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BY AND LARGE we're an uneducated lot. Compared to one of our most significant trading partners, Japan, the Australian workforce is way behind in the education stakes. In 1950 3.5% of those entering the labour force here had tertiary qualifications. In the same year in Japan, less than 1 % had tertiary qualifications. Now, around 8% of Australians entering the workforce has tertiary qualifications, but the figure for the Japanese is a massive 35%! That represents around a 4000% increase while we've barely doubled it over the intervening 30-odd years. The Republic of Korea predicts that next year around 40% of its labour force entrants will have tertiary qualifications.

Social attitudes contribute a lot to this problem, actively discouraging academic effort. It's a real indictment of the great Australian "she'll be right" philosophy that Australia's workforce compares so badly in skills with major trading partners. How on Earth we are going to drag this country through the post-industrial decline without doing something revolutionary, and soon? That we need to rapidly improve our labour force skills is a challenge currently facing those who chart our society's course.

Western society has moved from a pre-industrial agricultural economy to an industrial (manufacturing) economy to a post-industrial services-based economy. Curiously, Australia was spared the clamour of the industrial revolution. From the time of the first British settlement, we've had a predominently services-based economy. In the 19th century, roughly 50% of the labour force here worked in services. Around 71% or so of our workforce is currently employed in the service industries. But unless we can improve our labour force skills, we're simply going to fall well behind the rest of the western world. Development here will be (has been ?) severely retarded and we'll become relatively unskilled 'lackeys' to our trading partners and an economic 'sink' for their exports. Australia's workforce is too small for us to manufacture and export goods in quantity — unless our manufacturing becomes highly automated (or 'robotised'). We'd be better off exporting the product of our skills. Pity we have so few.

Sadly, there are few distinct signs on the horizon that our industry leaders, educational mentors and political servants are addressing themselves to the question. If we could only look around and learn from the successes of others, we might stand a chance of catching up.

Roger Harrison
EDITOR

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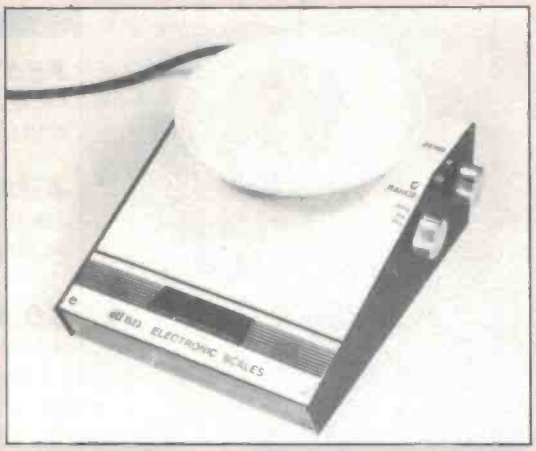

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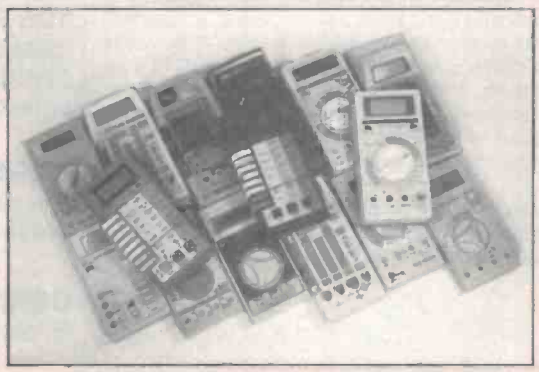

Digital multimeters reviewed

Technics SB-X100 loudspeakers

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NEXT MONTH

PRINTERS
Looking for a printer to get hard copy from your personal computer? It's a bit of a challenge deciding these days, the choice is so broad! Next month's issue features a great, grand survey of the variety of printer types, and explains the technology, the applications and how to choose the right type for your situation. Don't miss it!

25 W UHF BOOSTER AMP
When you're running a UHF mobile rig, you need all the power output you can get — repeaters notwithstanding. This low cost transmitter booster amp will give your signal quite a 'lift' without breaking the bank. Easy to build, easy to get going.

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Just the thing for clubs, halls etc. This project features four balanced low level inputs plus two high level inputs (one balanced, one unbalanced). Each input has a level control plus bass and treble tone controls (see the ETI-1421 preamp last month). The power amp employs our popular and reliable ETI-499 150 W MOSFET module to drive a 100 V line output.

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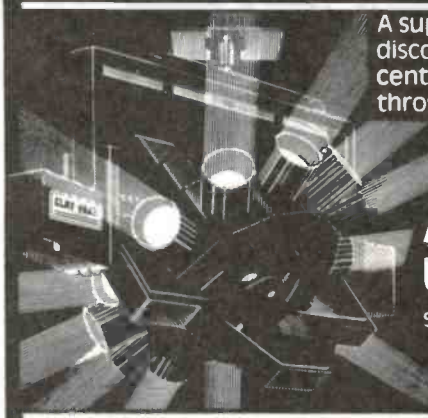

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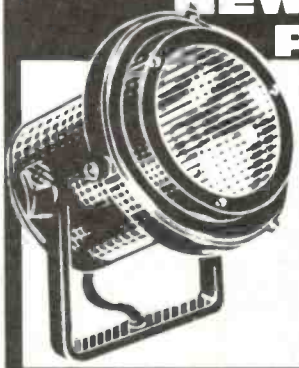

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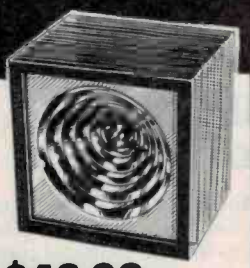

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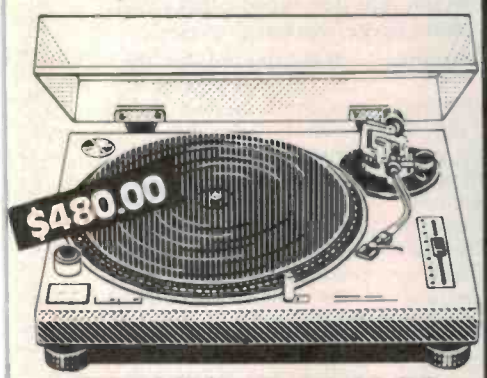

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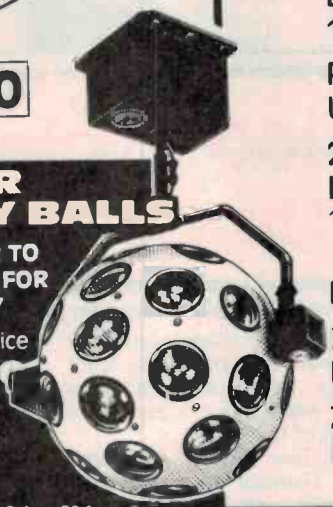

Illustrated above the Galaxy 36 from Coemar

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SMPTE conference

The Society of Motion Picture Engineers (SMPTE) is holding its first international convention and exhibition in Sydney at the RAS Showground between June 7 and 9, 1984.

This is the first time the SMPTE conference has been held outside North America.

The purpose of the conference is to communicate to members the latest developments in motion picture and television technology. To this end, over sixty papers will be presented on all aspects of the industry.

Speakers will include Garrett Brown, developer of the Steadycam. He will be introducing the Skycam, a high angle development of the Steadycam.

Peter Parkes, from Scientific Films of Oxford in the UK, will deliver a paper on technical aspects of macro photography, and Ed DiGuilio, from Cinema Products, will be talking about DataKode, an electronic method of encoding film to assist the editing process.

To coincide with the conference there will be an exhibition in adjoining pavilions. Forty companies are exhibiting their wares, and the products on display will encompass every facet of the industry.

Organisers expect 6000 people to attend the three day affair.

For more information write **P.O. Box 88, Willoughby NSW 2068** or phone the chairman on **(02)858-7500.**

Electric vehicles comp

The annual Electric Vehicle Endurance competition will be held at VFL Park, Waverley, Melbourne on the 24th June.

The competition has four categories for two, three and four wheel vehicles as well as a handicapped persons section.

Vehicles are allowed a maximum battery weight of 25 kg.

Entry forms and conditions of entry are now available from

AEVA, Melbourne Branch, 126 Russell Street, Melbourne. (03)63-7263.

Carbon-lithium battery. Rechargeable coin-type developed by Matsushita.

1000 cycle charge/discharge lithium battery

National's parent company in Japan, Matsushita Electric, has developed a three volt, carbon-lithium secondary battery which assures 1000 charge/discharge cycles.

Most conventional rechargeable batteries are either lead-storage or Nickel Cadmium types which have a maximum output of two volts.

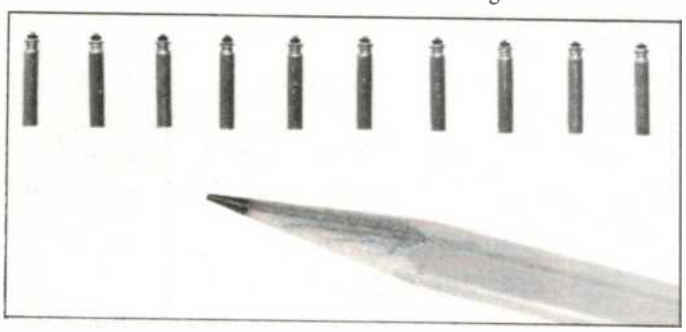
This new battery uses activated charcoal for its positive electrode and lithium for its negative electrode and has an organic electrolytic solution which is non-aqueous.

Conventional primary lithium batteries use poly-carbon monofluoride for the positive electrode and lithium for the negative which has produced products with high energy density that are compact and lightweight. However, there were not enough charge/discharge cycles (200 to 300 cycles) due to a pile-up of arborescent crystal, called 'dendrite', on the surface of the lithium negative electrode.

The new coin-type battery, dubbed 'R2020', is 20 mm in diameter and 2 mm thick, making it useful as a back-up power source for a variety of electronic equipment. Matsushita plans to introduce more coin-type batteries, box-type models such as storage batteries and cylindrical-type models, in accordance with market demands.

National has not yet announced plans for marketing the new battery to the Australian market.

Another Matsushita product that is now being mass produced is the world's smallest pin-type three volt lithium battery, measuring 2.2 mm in diameter and 11 mm in length.



World's smallest. Matsushita's pin-type lithium battery.

It is expected that the battery will be widely used for small electronic products such as wrist watches, calculators, memory cards, memory back-ups, microphones, hearing aids and toys.

The three volt battery initially will be marketed for use in ultra-small fishing floats with an LED for night fishing.

To achieve mass production the company had to decrease dimension tolerances to one-tenth that of previous models in the drawing process of the aluminium case and in the areas of plastic molding technology and assembling technology of the battery.

Some of its features are that it maintains a constant operating voltage when loaded, has a long shelf life with low self-consumption, is capable of lighting an LED with one battery and has superior temperature characteristics.

For more information contact **National Panasonic (Australia) Pty Ltd, 95 Epping Rd, Nth Ryde NSW 2113. (02)887-5333.**

No claptrap from Zap

Three former employees of Dick Smith Electronics have established a new electronics group to import and distribute the latest consumer electronics products from Asia.

Trading as Zap, the group have opened their first retail outlet at Parramatta. Zap will concentrate only on state-of-the-art or the latest products from the world's manufacturers and aim to have the products in their stores first.

Most consumer electronics products become available months after travellers see them for sale overseas. Pat Daly, former National Marketing Manager for the Dick Smith Electronics group, believes that electronics are becoming more and more a fashion business and consumers demand the most advanced electronics products.

Zap stock electronic products for the modern home — telephones, audio products, alarm systems, computers and electronic games at direct-import prices.

For further information contact Julie MacDonald on **(02)411-7707.** Zap's second Sydney store is now open at **Hornsby, Shop M1, Northgate Shopping Centre. (02)476-6122.**

Radio for print-handicapped

The radio station 3RPH aims its broadcasts at blind people or those whose sight is severely impaired, and at the physically handicapped who cannot hold or turn the pages of a magazine or newspaper.

3RPH operates just above the top end of the AM broadcast band in Melbourne from studios in Kooyong. The station uses facilities owned by the Association for the Blind in Talbot Crescent and is operated by volunteers. Some of the volunteers are handicapped themselves; at least two of the evening presenters are blind.

There is a professional staff of only *two* people, station manager Lindsay McMillan and coordinator Derrick Harvey. However, there is a force of about 150 volunteers who take care of the everyday running chores, the main one of which is to select material from magazines and papers which is suitable for the 'presenters' to read over the air.

The main style of programme is to read selected news, features and sports stories of particular interest to the handicapped audience.

The frequency of 1629 kHz at the high end of the dial is active from 8 pm to 10.30 pm weeknights with rebroadcast material from 10 am to 12.30 pm on Tuesdays through to Saturdays.

Derrick is hoping to expand the hours of operation from 7 am through to 10 pm seven days a week, to a level of 105 hours per week instead of the present 29 hours. He says this will be made possible by simply building the station volunteer staff up to at least 750 people.

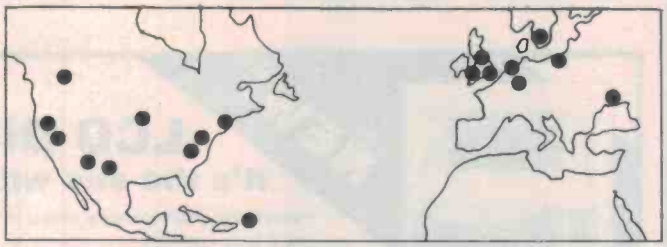
So if you believe you have talents in radio broadcasting get in touch with Derrick at 3RPH during office hours.

Security centre

Dick Smith has introduced an alarm system which they claim is easy to install and operate. Called the Dick Smith Security Centre, it is designated as Cat. L-5100 and retails for $199.

Some of the features of the unit are: six individually controllable sectors each with instant/delayed entry-exit and lockout facilities; resistive detection loops which makes bypassing or removal virtually impossible; variable entry/exit delays; fire alarm provision incorporated with 24 hour panic/fire/siren function; housed in metal tamper-proof box with inbuilt mains supply and room for back-up battery; security-type keyed operation.

The Dick Smith Security Centre is available at any Dick Smith store.



Astronomy probe. The sites indicate the position of the radio telescopes that will link up to map space.

New synthesis telescopes

Radio Astronomers are getting a better look at a 'jet' of expanding gas in a distant galaxy. The jet is moving faster than the speed of light, seeming to break one of the most fundamental laws of physics.

The discovery was made possible by a synthesis telescope.

Synthesis telescopes are the outcome of a drive by radio astronomers to improve the resolution of their instruments. Until the advent of radio astronomy this was done by building bigger telescopes. The problem is that the best of modern engineering cannot product dishes much bigger than those in use today.

To overcome this impasse astronomers have invented a technique known as interferometry, in which a number of telescopes are linked together. Because of the physical separation of the dishes there is a phase difference between the signal at the antennaes that depends to a certain extent on the shape of the source.

With these techniques it is possible to synthesise a dish that acts as if it were many hundreds, even thousands, of kilometres across. Recently, astronomers in the northern hemisphere synthesised a dish stretching from California to the Crimea. Included were the US Very Long Base line telescope (a permanent synthesis telescope), the big British dishes, and various units in Europe and Russia.

One of the targets of the project was the radio galaxy 3C120. This curious object resembles a quasar and has a jet of gas at its centre that seems to be expanding at a speed greater than the speed of light.

Meanwhile work is continuing on the Australian Synthesis Telescope, which is due for completion in time for the bicentennial. The project will involve the construction of six telescopes at Culgoora and one at Siding Springs in New South Wales. These will then be linked to the existing telescopes at Parkes and Tidbinbilla.

When completed the Australia telescope will be comparable with the Very Long Base line telescope in the U.S.

NEC develops advanced laser diode

Japanese computer and semiconductor maker, NEC, has developed an advanced laser device that can store, switch and amplify laser-optical signals.

One of the first of its kind in the world, the device, called a bi-stable laser diode, has been satisfactorily tested in a full optical data-transmission system.

A spokesman for NEC's optical and electronics laboratory said the bi-stable laser diode is similar to a semiconductor in function and could pave the way for the development of laser integrated circuits and eventually laser computers.

The new laser diode device will be used to amplify, switch and store laser or light signals, in the way semiconductors process, switch and store electric signals, he said.

Compared with electric currents, light signals require less energy and are virtually immune to electronic interference. Optical fibre cables, which are used to carry light signals, can drastically increase efficiency in communciations and data transmission.

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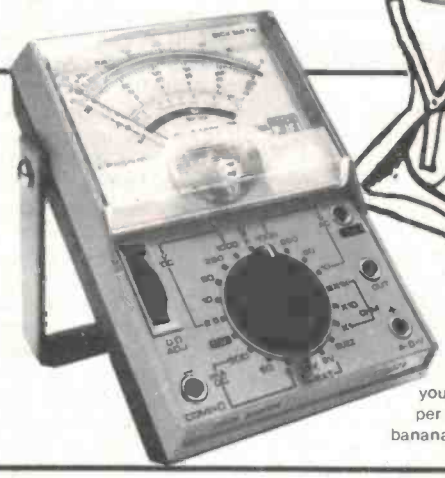
Where else but Dick Smith's could you find a quality digital LCD multimeter at this incredibly low price? We've cut no corners with this precision instrument. Features push button range selection, large 13mm LCD display, bench stand for easy reading, diode check facility and overload protection. With its 10A DC range, the Q-1444 represents excellent value for money! Complete with test leads and full instructions. Cat Q-1444

$59.50



Budget Priced Moving Coil with Continuity Test!

A compact, reliable multimeter with an added bonus: a built-in buzzer for continuity testing! Also has a battery checker PLUS 10A DC range - not normally found on low-priced multimeters! On top of this, you get a high sensitivity (20,000 ohms per volt) meter mirrored scale and large banana plugs for sure contact. Cat Q-1022

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Our Biggest Seller!

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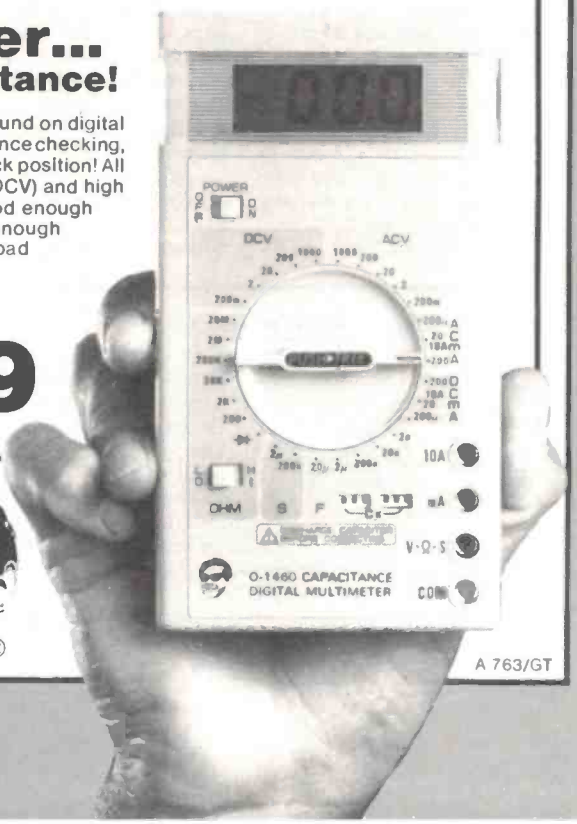
LCD Multimeter...
that measures capacitance!

Yes! It not only features the normal ranges found on digital multimeters, it also has five ranges of capacitance checking, two ranges of conductance AND a diode check position! All this in a very accurate (less than 0.25% on DCV) and high impedance (10Mohm) instrument that is good enough for the designer's test bench, but has a low enough price for the hobbyist. All this plus overload protection, automatic polarity, 2.5cm LCD digits - and measurement to 10A AC & DC. Cat Q-1460

- ★ 32 ranges
- ★ Up to 1kV & 10A AC & DC
- ★ Capacitance, diode & conductance too!
- ★ Auto polarity

$99



DICK SMITH ELECTRONICS

(See page for address details)

A 763/GT

Briefs

The first technical agreement for Japanese microprocessor technology above the 8-bit level was signed in April between NEC and Zilog of the USA. Under the agreement, Zilog will have access to NEC technical information on the new V series 16 and 32-bit processors.

Concern is being expressed in Japan at the increasing backlog that continues in orders of LSIs and semiconductors. Makers of finished products are being forced to extend delivery deadlines and some are reducing the quantities of earlier orders. Industry sources say the backlog is hurting the Japanese parts and components business even though device manufacturers are hastening expansion of their production capabilities.

Magraths Electronics has expanded its computer division and now occupies the entire first floor at the company's A'Beckett Street, Melbourne premises. The company has on display a total range of computer products from complete systems to software.

Ken Titman has been appointed manager of George Brown Electronics' Melbourne office. Bryan Bell has joined the company as a sales representative. He was previously employed at STC.

Labtam International, producers of the Labtam 3000 computer, has set up a Sydney office at 2 Help St, Chatswood. The manager is Les Cornell.

Four Japanese makers of TV antennas are preparing to field test flat, rather than parabolic, antennas for receiving direct satellite TV signals. The basic design was developed back in 1981 using a 90 square centimeter surface to gain 20 dB. Recently they have improved this figure to about 36 dB, or nearly the same rating as a 750 mm parabola. The flat aerials use copper clad laminated boards and are less expensive than the equivalent parabola.

The software wholesaler, Software Source, has set up what it calls a 'software source education centre', in Bondi Junction, Sydney. Managing Director Greg Lister said, "We believe that training is fast becoming the most important aspect of a computer system. Good software, and well trained operators are the key to success". Courses are being designed for the companies, authorised dealers, as well as the end users.

NOTES AND ERRATA

February '84, Ideas for Experimenters: On page 116 the 'electric floor heat earth leakage monitor' normally ticks at about 1 Hz, not 1 kHz as was printed. It was also stated that any small leakage of ten milliohms or less will increase the frequency of the output. The value of the leakage should be ten megohms.

February '84, Compost Calculator: A few errors were discovered in the flow chart on page 76. In the top half of the diagram, second from the left, under the heading 'flowchart compost' step six should be FOR J=1 TO N. On the far right under the heading 'search array and calculate C/N ratio', step four should be IF A(1,4)<−0.125.

In the bottom half of the diagram the steps following '500' should be D=+1, C=1 and H=1. Under '550' it should be D=−1. The third step following '600' should be C=C+D. Under '700' it should be D>0.

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DIGITAL pH METER

REF: EA DECEMBER 1982

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The unit features our versatile 3½ digit DPM display, high resolution and simple construction.
The Jaycar kit includes quality ABS box and BNC connector.
Cat. KA-1492 **$69**

Special lab quality pH probe to suit (includes 2 bottles of calibration solution as well as BNC connector).
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Remember the days when high grade precision laboratory multimeters were available only from the U.K. and then they cost a King's Ransom?! - Well that's history - The new Q1040 is everything a high quality meter should be *PLUS* it checks transistor HFE and ICO and measures capacitors from 50pF to 50uF.

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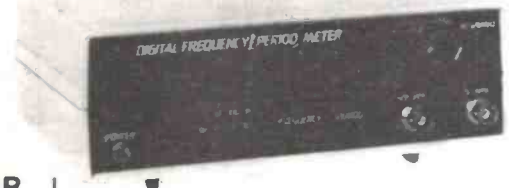
- ★ 250mV, 2.5V, 10V, 50V, 250V, 1000V DC
- ★ 5V, 10V, 50V, 250V, 1000V (10K/V) AC
- ★ 10uA, 2.5mA, 25mA, 500mA, 10A DC Current
- ★ 10A AC
- ★ x1, x10, x1K, x10K resistance
- ★ Transistors NPN/PNP HFE 0-1000, ICO 0-50uA
- ★ Capacitors 50pF to 3uF, 0.1uF to 50uF

Cat. QM-1040 **$89.95**



50/500MHz DIGITAL FREQUENCY COUNTER

REF: EA DECEMBER 1981 - FEBRUARY 1982

This is a high performance unit that is also easy to build! The new design uses just 5 IC's, measures period and frequencies up to 500MHz (with prescaler). It features a bright 7 digit display and outperforms readybuilt units costing 2-3 times more!
We believe that the Jaycar version of this kit is by far the best. Not only do we supply 2 x GOLD plated BNC input connectors we supply a special pre-punched heavy plastic front panel that is screen printed in epoxy ink. The assembled unit looks a million dollars! Watch out for kits that only provide cheap front panels!
The standard kit will work to 50MHz.
Cat. KA-1390 **$119**

A 500MHz prescaler kit (which fits straight onto the main circuit board) is available.
Cat. KA-1392 **$29.50**

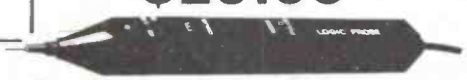
LCD THERMOMETER

REF: EA FEBRUARY 1982

This is a handy portable thermometer with a 15mm high 3½ digit readout. It can measure temperature from below freezing to around 100°C with a resolution of 0.1°C! Two sensors are provided with the kit. One fits into the case itself and the other for "remote" sensing. The kit is complete, simple to construct and works well. Battery life is excellent.
Cat. KA-1404 **$74.50**

LOW COST LOGIC PROBE

This probe has 10MHz bandwidth and will work at TTL or CMOS logic levels. LEDs for the LOGIC 'HIGH' and 'LOW' and 'PULSE'. Also has pulse/memory switch.
Cat. QT-2210 **$29.95**



LCD CAPACITANCE METER

REF: EA MARCH 1982

This kit is an inexpensive capacitance meter with unambiguous digital readout. It can measure from 1pF to 19.99uF in just 3 ranges! The Jaycar kit includes the 3½ digit LCD module, case and front panel as well as all other components. Many hundreds of this kit have been sold. It is easy to build and reliable.
Cat. KA-1420 **$74.50**

KAISE DIGITAL MULTIMETER SK 6100

Check the specifications/features of this superb Digital Multimeter.

- Autoranging with manual override
- Auto polarity displays - sign when probes reversed
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- Low battery warning BATT sign shows
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- Fuse protected, spare fuse provided
- Zero adjustment, zero adjust button - a must if you change test probes
- LCD display, magnificent clear readout
- Inbuilt buzzer, available for continuity test, overload warning and switch warning
- Ranges ±1000V DC/600V AC, AC and DC current, resistance 200 (resolution 0.1 ohm) to 2000K ohm (resolution 1K ohm) in 5 ranges autoranging
- Accuracy 0.5% DC, 0.8% AC

Cat. QM-1525 **$59.95**

FUNCTION GENERATOR WITH DIGITAL READOUT

REF: EA APRIL 1982

This attractively housed (matches the KA-1390 DFM) unit produces sine, triangle and square waves over a frequency range from below 20Hz to over 160kHz with low distortion and good envelope stability. It has an inbuilt 4-digit frequency counter for ease and accuracy of the frequency setting.
The Jaycar kit is complete and even includes a free Tilting Bail worth $5.
Cat. KA-1428 **$99**

MINITUNE

REF: EA JULY 1983

$42.95

The Minitune is a compact engine performance analyser with LCD readout. The price of the kit is amazingly low - lower than the normal cost of two of the major components the LCD module and the case. The Minitune will measure voltage, resistance (down to a very low range), RPM and dwell angle.
Cat. KJ-7012

LOW COST DIGITAL MULTIMETER KIT

REF: EA MARCH 1983

Almost every day we are asked for a multimeter kit. Up until now we thought that it was just not worth it considering the fine low-cost built-up units available. The DP2010 changed all that.
This kit, fully imported from the U.K. uses the famous DPM-05 custom LCD/Voltmeter to achieve phenomenal accuracy at very modest cost!
All parts are included to complete the meter including an attractive and colourful front panel. (A 9V battery is required).
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Eveready 216 (red) 9V battery
Cat. SB-2370
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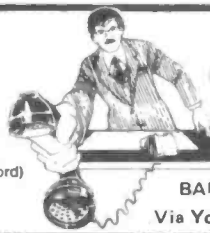

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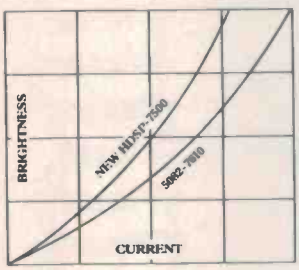

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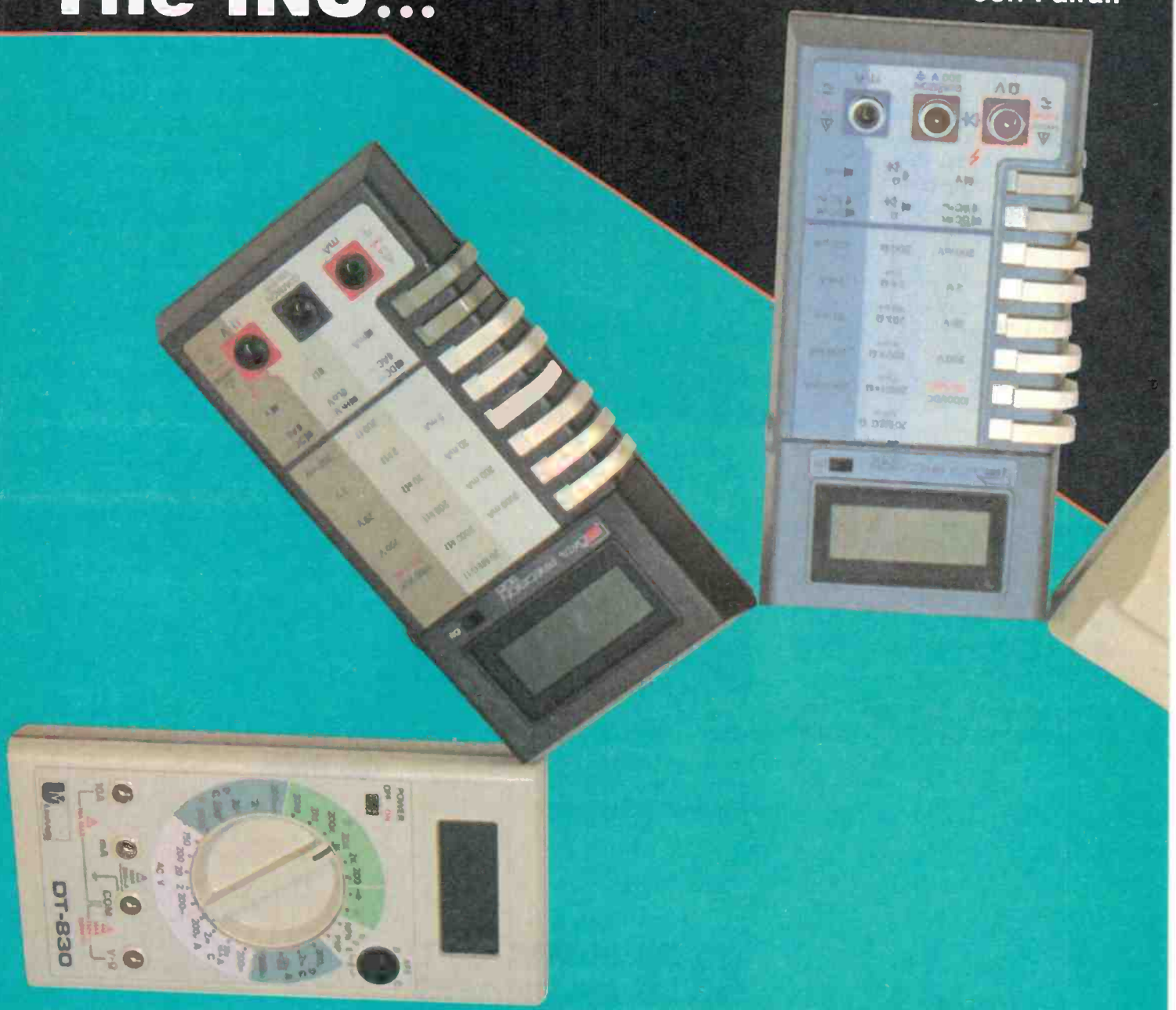
MODERN MULTIMETERS

The INS...

Jon Fairall



...and OUTS

The multimeter is probably the most important single piece of test gear anyone concerned with electronics will buy. But with the digital revolution in multimeters the purchaser is faced with a bewildering variety of fancy shapes and sizes. We've had a look at the latest multimeters, how they function and the best way to go about buying one.

THE CORE OF ELECTRONICS is measurement. Unlike the motor mechanic or plumber who can hear and feel when things go wrong, in electronics we have to rely on numbers. (Of course, this excludes the occasional cloud of smoke and electrified technician that issue forth from every good work bench on occasion).

Techniques for doing this measurement have grown up with the subject. Over the years, people have learnt how to measure the various electrical parameters to an amazing degree of accuracy. In reasonably competent electrical laboratories around the world accuracies of one part in a million are commonplace. So it is not surprising that, as an industry, we take some convincing when people threaten to change the tools of the trade.

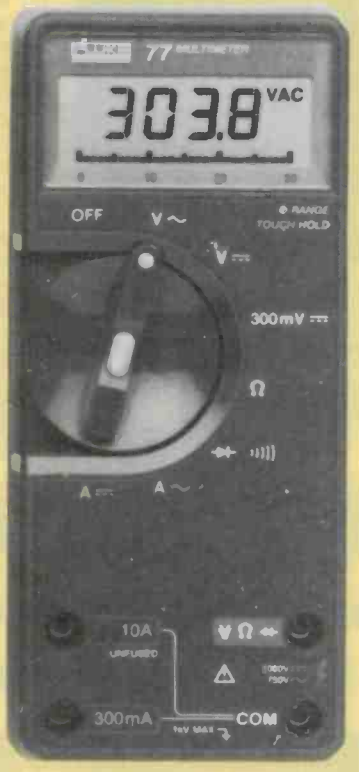
The change from analogue to digital multimeters (DMMs) has been a bit like that. The first DMMs were available in the early 60s. Twenty-odd years on, we are just starting to really accept them as working tools, and to consign the old moving coil meter to the junk heap.

In the past few years, DMMs have become cheap enough for everyone to be able to afford them. However, it requires some thought to learn how to use them. Like the old analogue meters before them, they have a few tricks to play on the unwary. In this article we have had a look at the handheld DMMs that will directly replace the old multimeter on the workbench. Hopefully, we have selected the important criteria by which you can tell the good from the bad.

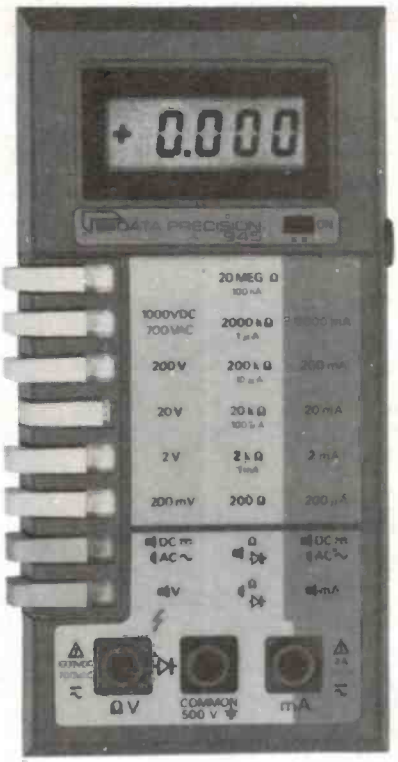
Methods

Analogue meters were arranged such that the meter would move in response to the

Fluke 77. A representative of the Series 70, which, according to its distributors Elmeasco, is selling extremely well. This is not surprising, since it combines Fluke's name with a very affordable price tag. It's most spectacular feature is the analogue bargraph, even if it seems a bit of a gimmick. Real strengths are rugged construction and excellent electrical parameters.



Modern Multimeters



Data Precision 945. Probably the cheapest 4½-digit handheld DMM on the market. The US-based manufacturers claim to have achieved levels of accuracy unsurpassed in this price range and quite in keeping with the resolution given by the fourth digit. Its ac performance is not remarkable however. The 3½-digit model is the 935 — a bit pricey but solidly built. The distributor is Kenelec.

flow of current through the probes. By the application of Ohm's law, the meter could be made to read Ohms and volts as well as current. This leads to a fairly standard arrangement for analogue meters.

For reading amps and volts the meter would be connected to the circuit through a series resistor and the meter would be read against an appropriately calibrated scale. To measure resistance, an internal battery would be connected across the circuit and the resultant current would cause the meter to respond (see Panel 1).

Digital Multimeters employ a variety of techniques for doing the same job. The most common is called *dual slope integration*. Essentially it involves turning the input into a time period and then passing this information through various logic systems for display in the appropriate units. (See Panel 2 for a fuller explanation).

Another commonly used system, is called *successive approximation*. In this system, the voltage is compared to a succession of internally generated reference voltages. Although easy to implement, this system suffers from much longer response times than dual slope integration, and it's less accurate.

Whatever the method used, the modern generation of DMMs are far superior to the old VOMs. Accuracy and resolution are now orders of magnitude better than achieved in earlier instruments which cost far more. The timing period has been decreasing rapidly as well, so that the old objection to DMMs, that they couldn't read fluctuating voltages, is rapidly becoming obsolete. Indeed, the latest meters from Fluke, the series 70, have a bargraph display that updates itself twenty three times a second. This is faster than the eye's 'flicker time'.

Kyoritsu 1003. Distributed by Bell Instruments, this 3½-digit meter features 22 ranges. Unlike many other types, the amps and ohms ranges on the 1003 use the same 'hot' terminal.

PANEL 1

HOW TO USE A MULTIMETER

There are three fundamental measurements you can make with a multimeter, corresponding to the three electrical parameters linked by ohms law.

When measuring current the meter sits in series with the circuit (Figure 2), so that any current flowing in the circuit is also flowing through the meter. The meter should present no resistance to the flow of current, and in practice it usually presents very little.

However, current measurements are rarely used. For a start, the circuit must be physically broken to get the meter in series with it. Just as importantly, when the meter is in the current mode it is at its most vulnerable, with all the (possibly excessive) current in the circuit flowing through it. Usually, the meter input is arranged so that a circuit element between the inputs causes a small voltage drop between them (see Figure 3).

Since the amount of current flowing is proportional to the voltage drop it can be measured in a shunt configuration. The problem is, though, that the small circuit element between the inputs must withstand all the current flowing in the circuit. This is why the maximum current the meter can tolerate is marked so boldly on the front panel of the meter. Several manufacturers actually advise, in their handbooks, that the meter can become unsafe if current specifications are exceeded. It's a good idea to handle with care!

Voltage measurement is the most useful way of gaining information about the circuit under test (see Figure 4). It is made in parallel, either by placing the meter in shunt around a single component, or between a point in the circuit and ground. In any event the resistance of the meter should be as high as possible, since the meter will represent a path to current flowing in the circuit. This results in 'circuit loading'.

To understand the cause and effect of circuit loading, imagine the meter is replaced by its input resistance, as in Figure 5. In both cases the same amount of current will enter, and the same changes in voltage will occur. It's easy to see that the real voltage at node A is 2.5 V. Yet a meter with a 10M input resistance will read 1.6667 volts. To see why, consider that the resistance between A and the ground is really only 5M with the meter connected.

Circuit loading is a simple demonstration of the physical maxim that you can't measure anything without changing it in some way. But you can minimise the effects. Imagine for instance, that you were trying to measure the voltage at Point A of Figure 5 with a meter that had a resistance of only 20k. The meter would read 10 mV, probably not observable. On the other hand, do the same thing with a 1G input resistance. It comes out at 2.49 V.

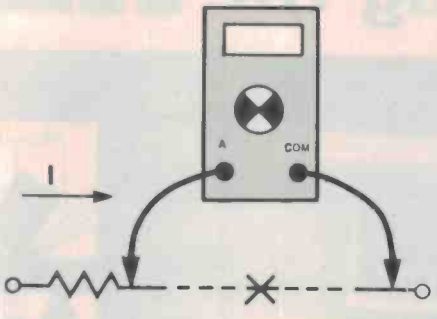
In other words, the higher the input resistance, the better. As a rule of thumb, you don't need to worry about loading provided the input resistance is an order of magnitude (10X) greater than the highest resistance in the circuit. If it is, interpret your results with care.

Resistance readings are made in series with the resistance under test, as in Figure 6. In the resistance mode an internal battery in the meter is connected in series with the meter circuitry and the resistor under test. Current then flows from the common terminal of the meter into the resistance. The amount of current is determined by the size of the resistance and it is this current that the meter actually reads.

Two points need mention. Firstly, the amount of current used in this test is very small. If you leave the power connected to the circuit when making a resistance measurement you may find a very expensive cloud of smoke pouring out of your meter.

Secondly, when making resistance measurement *in situ*, make sure you don't have another bit of circuitry connected in parallel with the bit you wish to measure. In practice it can be very difficult to eliminate this without removing the component from the board.

Figure 2. Current measurement



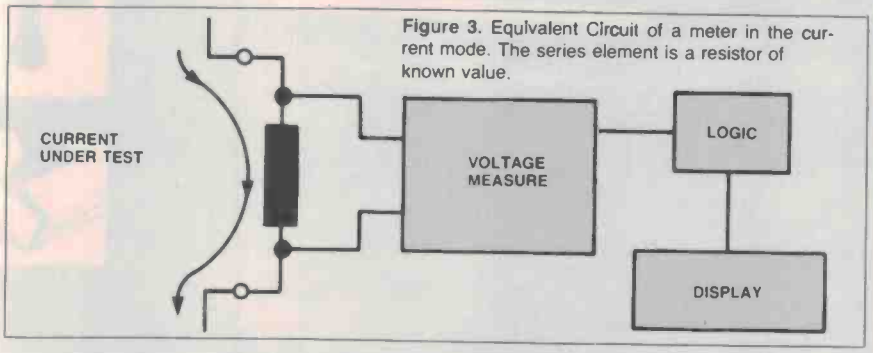


Figure 3. Equivalent Circuit of a meter in the current mode. The series element is a resistor of known value.

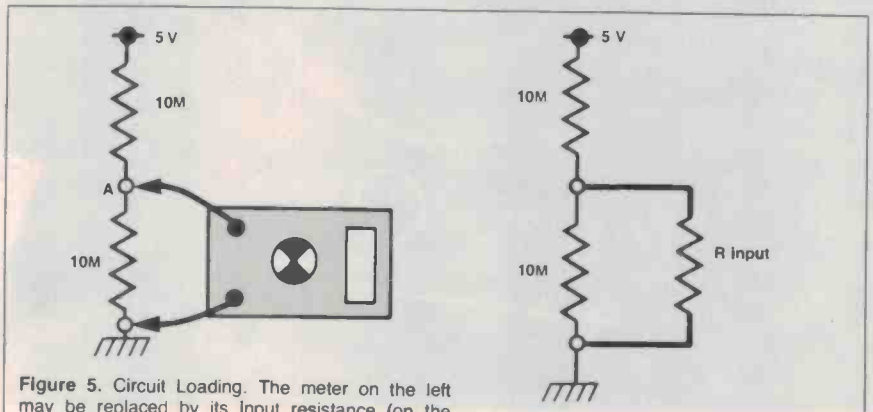


Figure 5. Circuit Loading. The meter on the left may be replaced by its input resistance (on the right) in order to determine the behaviour of the circuit.

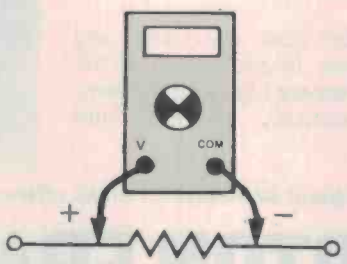


Figure 4. Voltage measurement. The common terminal always goes to the negative side.

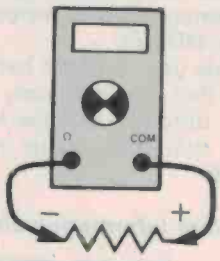
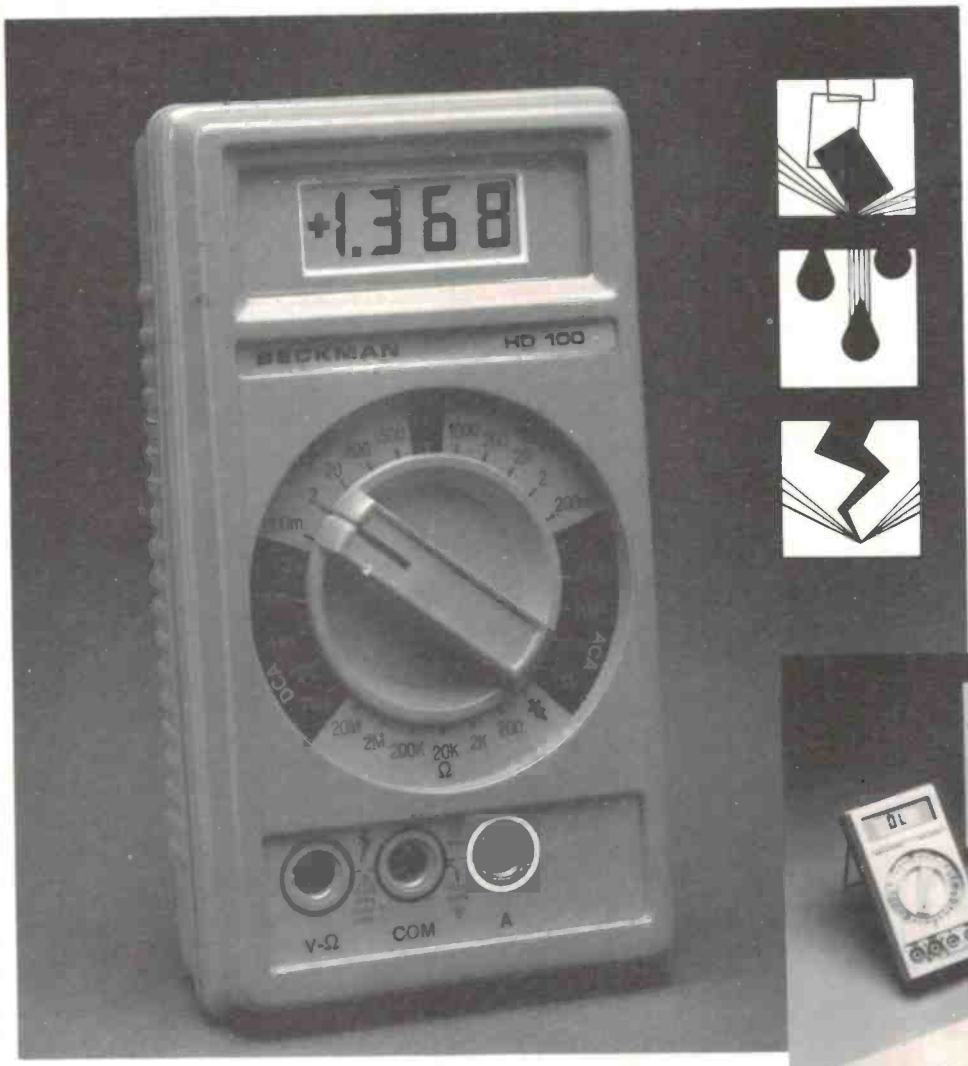


Figure 6. Resistance measurement. The internal battery usually has its positive connected to the meter's common terminal.

Now, more than ever, engineers are switching to Beckman digital multimeters. Introducing the HD-100



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Other models available: 3010, RMS 3030, 3020B, 3020, RMS 3060, 3050.

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Modern Multimeters

PANEL 2
DUAL SLOPE INTEGRATION

The most popular method of getting the measurement from the probes to the display is called Dual Slope Integration.

The analogue input will usually be passed through some kind of conditioning network to an integrator. The integrator begins to ramp up in response to the input signal. The slope of this ramp is determined solely by the input level.

Meanwhile, the system clock is counting off a predetermined number of pulses. When this reaches some convenient figure the input is switched from the analogue input to an internal reference voltage of opposite polarity to the input.

At this point, (C in Figure 1) the output level is determined uniquely by the analogue input. The analogue-to-digital conversion can now begin.

The input is connected to a standard reference voltage of the opposite polarity to the analogue input. This causes the integrator to ramp down at a predetermined rate.

The clock now generates a binary output that counts up until the integrator output reaches zero (Point D). When this happens, the count is transferred to the logic circuits, the integrator is reconnected to the input and the cycle begins again.

Meanwhile, the binary count that was transferred to the logic circuit is fed to the display in the required format of volts, ohms or amps, depending on the position of the operator's switches.

There are a number of advantages and disadvantages to doing things in this way. One of the advantages relates to noise immunity. Due to the relatively long A-D period the noise output tends to zero. This is because of the integration function, which, over time, tends to make a random input equal zero.

But the length of the A-D period also limits the ability of the system to track a rapidly changing input level. Unfortunately, we cannot speed up this conversion to any rate we like. Not only noise immunity, but also resolution depend on us having as long a time as possible for the A-D conversion. To see this, consider that the resolution depends on the number of pulses that occur during the A-D period (between B & D in Figure 1). If there were only two pulses, it would only be possible to distinguish two voltage levels. A million pulses and you have a million levels.

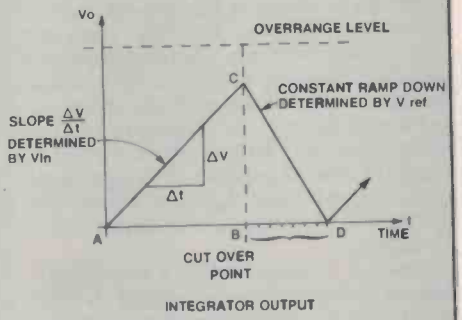
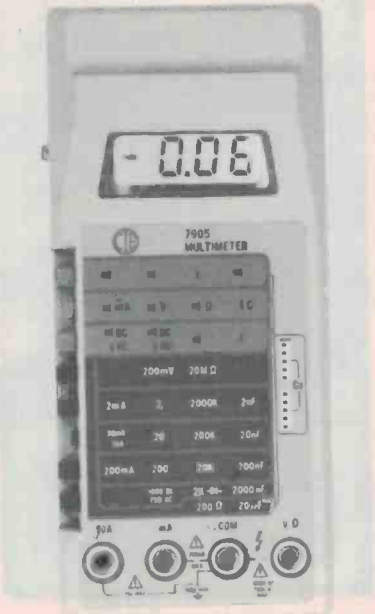


Figure 1. Integrator Output

Aaron MM210. The colour coordination in this little meter is terrific, but the case feels very flimsy. It's main advantage is 1G input resistance, which, for the price, is unbeatable. The distributor is Neotronics.

Q 1460. Dick Smith has put his face on this one, and undoubtably it will be a winner. It feels flimsy, however, which it shouldn't be for the price, but to compensate you get a capacitance tester.



CIE 7905. One of the better Taiwanese-made meters. It has a stylish case and sits in the middle of the model range, both in terms of price and electrical performance. Note the capacitance tester on the right hand side. Distributed by Lamron.

Choosing a meter

Part of the price of success for the DMM, however, is popularity, not only with the consumer, but with the manufacturer as well. The result is that whereas there were less than ten major brands of DMM several years ago, there are now 35 or so, and with them has come overchoice. So, if you are in the marketplace, and you don't want to buy on the basis of the pretty colours on the case, read on.

The first question is undoubtedly: *how much?* The DMM has come down in price to the extent that around sixty dollars will buy you an instrument in which almost every parameter you might care to name is as good as the best of analogue types. Top of the range for handheld types is $500-$800. There is, as they say, a price to suit every pocket.

Given that you know how much you are prepared to spend, the next consideration should be the number of digits. At the low end of the market almost all the available models will be the 3½-digit type, i.e: the first digit can only be a 1, so full-scale reading is 1999. If you need 4½-digits, be prepared to pay. Incidentally, make sure you

Don't miss distributors index on pages 35-36.

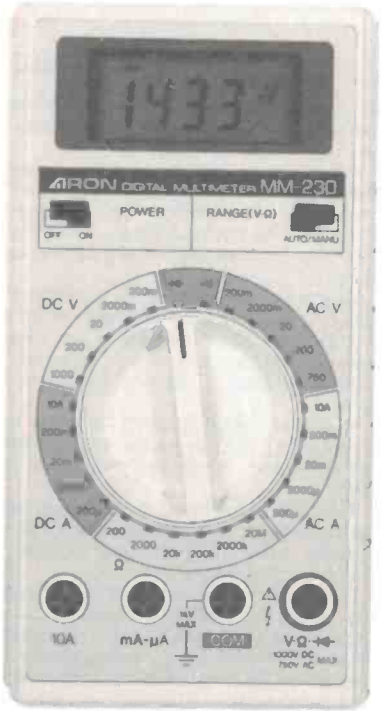
Modern Multimeters

get a meter with an LCD rather than a LED display. The LEDs play havoc with battery consumption!

The number of ranges should influence your choice as well. As a general rule the more ranges, the more you will pay, but the better the resolution. Typically, there will be five ranges of ohms, volts and amps, and switching between them can be a major problem. In the analogue meter the standard way of doing it was to have one or two rotary switches which could be turned to select the desired function and range. Some digital meters have the same layout. No doubt their designers see some advantage in familiarity.

Another system involves a row of push buttons down the side of the meter. Usually this is set out with range selectors at the top and function switches below. A third method, favoured on benchtop units but not very common on handheld DMMs, is a set of pushbuttons on the front panel of the meter. Often this system is used with an autoranging function — more about this later.

Choosing between these various options is very much a matter of individual preference, and to a lesser extent, a function of how you use the meter. Buttons down the side clearly favour the person (right handed only) who holds the meter in his hand and wants to be able to change function without changing his grip. It tends to get a bit fiddly if the meter is lying on the bench. The converse holds for the rotary switches. They are great if you habitually use the meter on the bench and want to be able to change ranges with a minimum of fuss.



Aaron 230. It features the same colour scheme as the MM210, and suffers the same disadvantage of case design. However it is jam-packed full of good features and has very high input resistance. The distributor is Neotronics.

YFE or University YF1100. At $75, a typical middle of the range DMM with side buttons. Notice the transistor test sockets, which feature dual emitter sockets. The distributor is University Graham.

Another point worth noting is that most of the DMMs have separate input sockets for the positive lead, depending on the function being selected. Obviously this is very fiddly in practice, but it does have the enormous advantage that it is impossible to inadvertently put the meter into the current mode while trying to measure volts.

While you are looking at the range buttons, have a look at the extent of the ranges themselves. Most of the meters on the market today will read up to 1000 Vdc, 750 Vac, 20M and 10 A. It's worthwhile thinking for a minute about the likely uses of your meter before deciding which ranges you need to emphasise. The Univolt DT840, for instance, only ranges up to 200 mA, but that's not a problem if you rarely make current measurements. The Fluke 77 overranges at 3M on the resistance scale. Will you ever need more than that?

. . . to page 25 ▶

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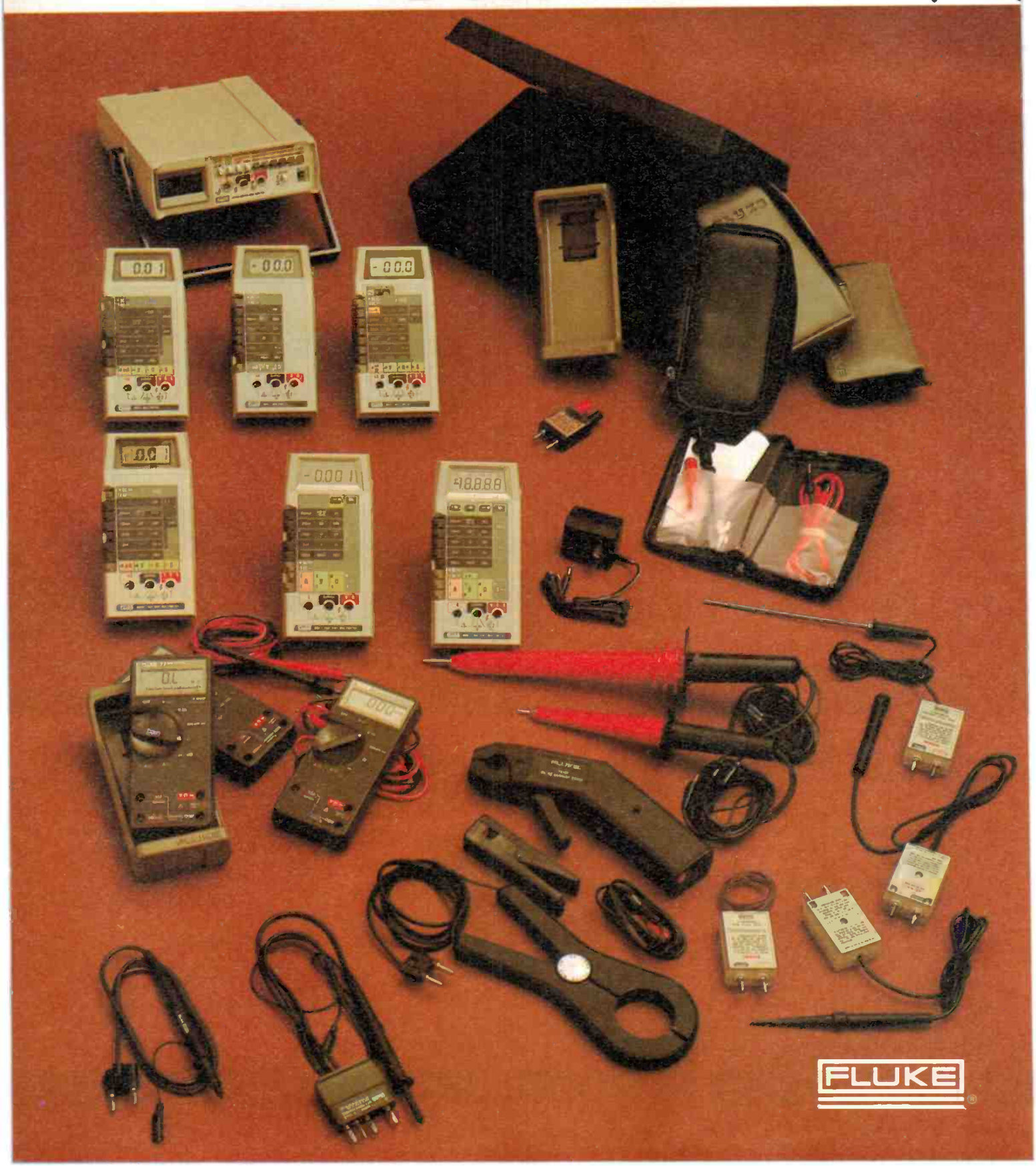

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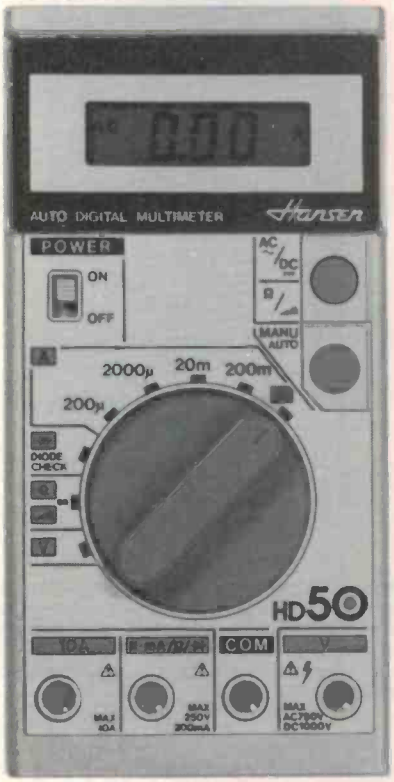


Hansen HD 50. A rather pricey meter from Japan, distributed by University Graham. It combines autoranging on volts and resistance with a comprehensive manual range function on current. The distributors should undoubtedly rewrite the manual.

The problem with having lots of ranges is that you need lots of switches. One way around the problem is to put an autorange function into the meter. With this facility, the meter will select the appropriate range once the operator has selected the function. Such meters represent the ultimate in simplicity of use, but they do suffer from the disadvantage that there can be a considerable delay between the time you put the probe on the test point and the time the meter finally gives you a stable reading. This is a problem inherent to DMMs, and it's made worse by autoranging. One of the best features of the old VOM was that you could 'probe and glance'. It doesn't work with the DMM.

Although there doesn't seem to be much variation in the models we tested, it is a worthwhile exercise to check the *input resistance* of a unit before you consider buying it. The industry standard is 10M and most manufacturers in our survey claim to have achieved this. Indeed, some claim to go orders of magnitude beyond it. The Aaron MM220, for instance, is claimed to have an input resistance of 1G ($1X10^9$R) on its 200 mV range.

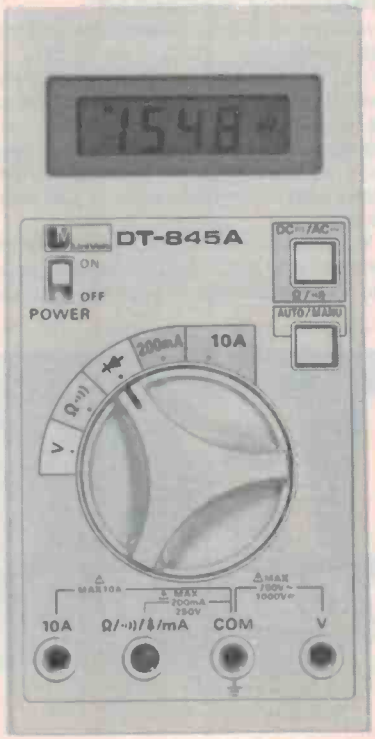
comparison tables on pages 28-31

Extras

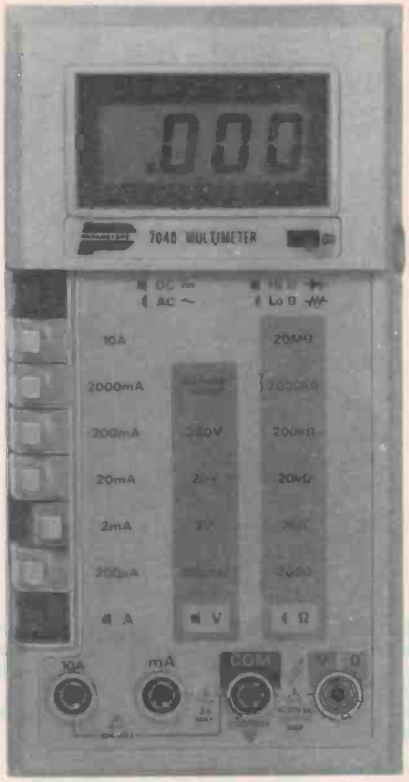
There are a few extra facilities it's worth thinking about before purchasing your meter. By and large they don't seem to add much to the cost, and if you have some special application in mind they can save a fair bit of messing about. For instance, models are available with capacitance testers on them. The Dick Smith Q 1460 has this facility for less than $100. Transistor testers such as on the YFE1100, are another facility that can be very useful. By pressing one button you can determine the polarity of an unknown transistor, as well as its beta.

If continuity testing is going to be an important part of the work you do with the meter, an audio indication of continuity can be very useful. It allows you to make the test without taking your eyes off the probe, a handy facility when trouble shooting on crowded boards. But bear in mind that there is usually a minimum resistance below which the buzzer will sound. Sometimes it's as high as 120 ohms, so you can't reliably check for things like dry joints, or partially open components.

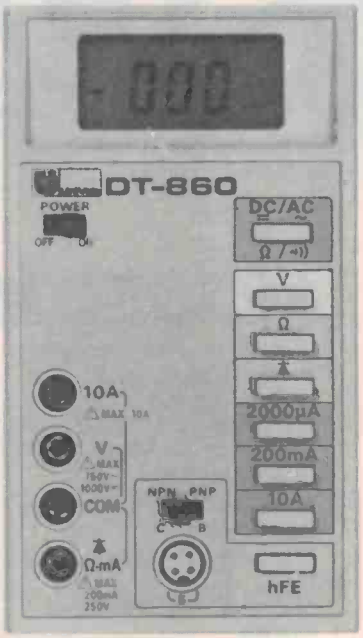
Another trap to watch for with buzzer continuity is that there is sometimes a considerable reaction time while the meter does an A-D conversion. It can be long enough to deceive an inexperienced user.



Univolt DT845A. A meter from Univolt with autoranging facilities. Manual function can be selected by use of the button on the front panel. Unfortunately there is no indication of which range the meter is currently operating on. However it's extremely simple to use once you learn how. It's distributed by Benelec.

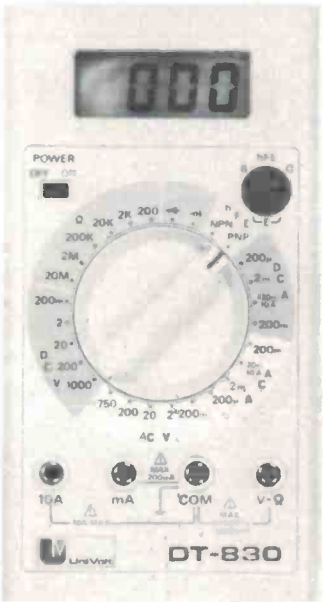


Parameters 7040. A Korean-made meter sold by Parameters under their own badge. It is short on fancy extras, but makes up for it with a tough operator resistant case. It's nice to use.



DT860. A semi-autoranging meter from Benelec. The panel layout is very unusual but very easy to use. It also has a transistor tester and the highest input resistance in the Univolt range. ▶

Modern Multimeters



Univolt DT830. A fairly typical Japanese unit from Benelec. It offers all the usual features plus a transistor tester. Note that the polarity of the transistor can be set by movement of the main rotary knob. Univolt brand-name this model for AWA (model DM 500).

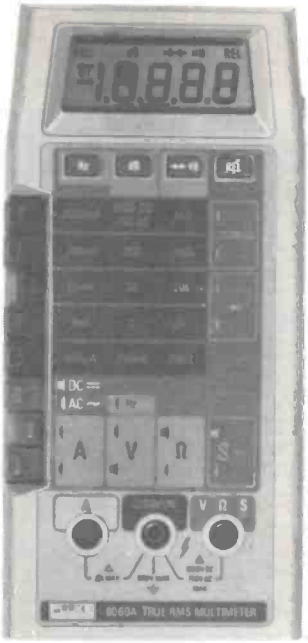
Closely allied to this sort of 'one eyed' reading are those meters that have an 'auto lock' button. This will freeze the reading on the display even after the probe has been lifted from the test point.

In certain applications it's worth thinking about a decibel (dB) reading on the display. Typically, such instruments will either change a voltage reading into its equivalent dBm reading (i.e: relative to 1 mW in a 600 ohms load, or else they will give you a dBr reading, i.e: a decibel level *relative* to some voltage you have already put into the machine). Clearly, this is useful for someone who habitually spends time with analogue equipment, (but bear in mind the following remarks on ac response).

Frequency Response

If you intend spending some time looking at high frequency inputs, say 1 kHz and above, the ac performance of the meter is of some consequence. For a start, make sure the input is ac-coupled. This will allow separate determination of the ac and dc components of the input. A dc-coupled meter allows only a determination of the sum of the two.

You also need to consider the difference between *true RMS* and *averaging* meters. The true RMS meter will usually have some



Fluke 8060A. Really outside the class of the other meters in this survey. It has a performance usually only associated with bench meters. Unfortunately its price is more like the bench meters than the other DMMs. Lovely if you've got the money. The distributor is Elmeasco.

. . . continues page 33.

CURRENT TECHNOLOGY

This is the sensational new Hioki 3211 Pen – DMM, a technological breakthrough in digital multimeters. Designed to be held in one hand like a large pen, it is extremely useful for trouble shooting and maintenance work on computer systems and other microcircuits.

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But you won't really know how good it is until you give it a try.

Special introductory price **$78.*** Normally $92. *Plus Sales Tax.

Specifications

Display: 3 ½-digit, maximum reading of "1999", autopolarity, unit and other annunciators.
Ranging: Auto.
Overrange Indicator: "1" in MSD column blinks.
Battery Low Indicator: BATT mark lights.
Sampling Rate: 2 per second.
Environmental Conditions (Operating): 0 ~ 40°C, < 80% RH.
Maximum Allowable Input: Volts; 700 VDC or DC + AC peak. Ω/Cnty.; 250 VAC max.
Dielectric Strength: AC 2000 V/1 min (between input terminals and case).
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Dimensions: 163L x 19W x 28H (mm).

Measurement Range and Accuracy

(Specified for 23°C ± 5°C, < 80% RH, no condensation.)

	Range	Resolution	Accuracy	Notes
DC V	2V	1mV	±0.5%rdg ± 4dgt	Input resistance approx. 12MΩ
	20V	10mV	±0.7%rdg ± 4dgt	approx. 11MΩ
	200V	0.1V		
	500V	1V	±1.0%rdg ± 4dgt	
AC V	2V	1mV	±1.0%rdg ± 8dgt	Input resistance approx. 12MΩ (40Hz to 500Hz) approx. 11MΩ
	20V	10mV		
	200V	0.1V		
	500V	1V		
OHMS	2kΩ	1Ω	±0.7%rdg ± 4dgt	Open terminal voltage < 0.45V
	20kΩ	10Ω		
	200kΩ	100Ω		
	2000kΩ	1kΩ	±1.2%rdg ± 4dgt	
Continuity Test				Open terminal voltage 1.5V (approx.)

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Measured Frequency Response

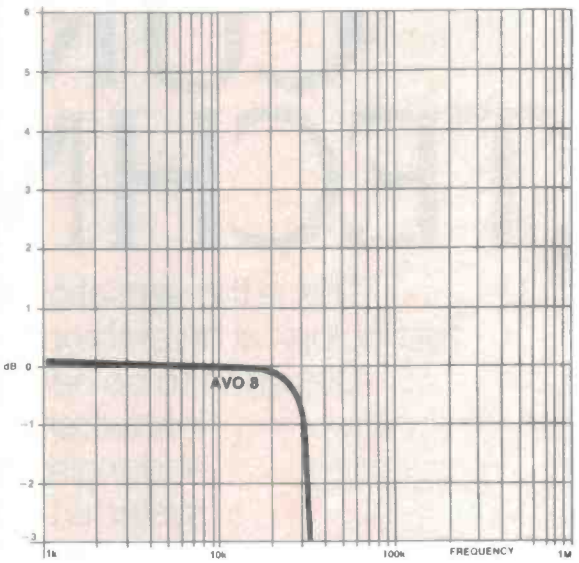
Graphs of frequency vs. response of some typical multimeters.

The frequency graphs for this article, and the determination of bandwidth used in the table are based on figures established in our laboratory at ETI. We used a Wavetek Model 166 as the signal source. A Telequipment D61a CRO with x10 leads was connected across the Wavetek and the meter under test.

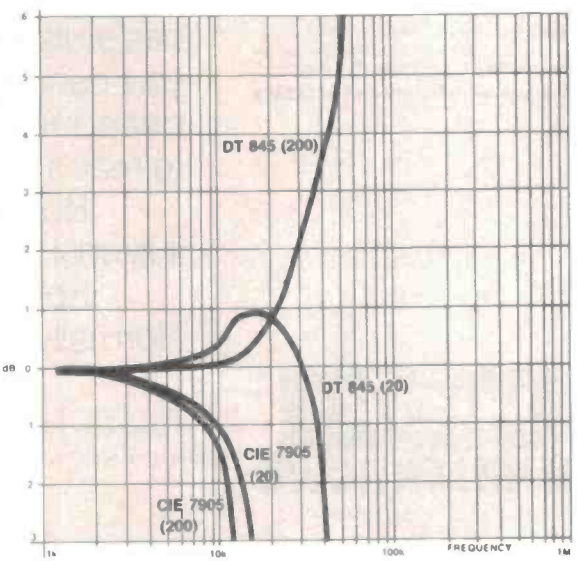
The sine wave from the signal generator was measured at (nominally) 14.14 volts to yield 10 volts RMS on the meter at 100 Hz. The frequency was then increased to give the graph shown here.

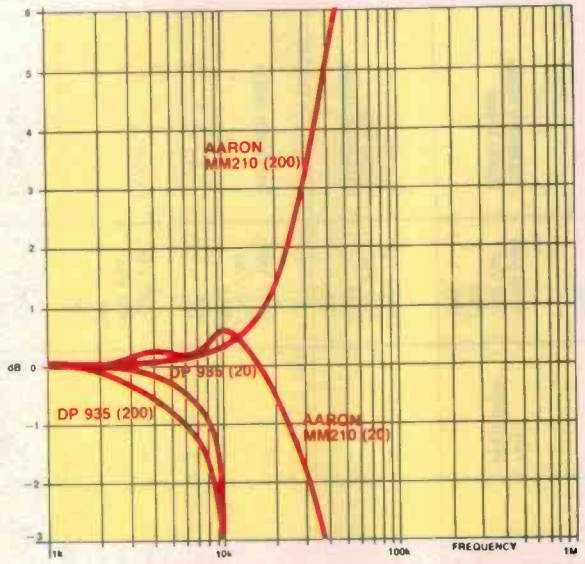
To establish the bandwidth we wound the frequency up until the meter read 3 dB greater or less than the nominal. Note dB = 20 log V1/V2.

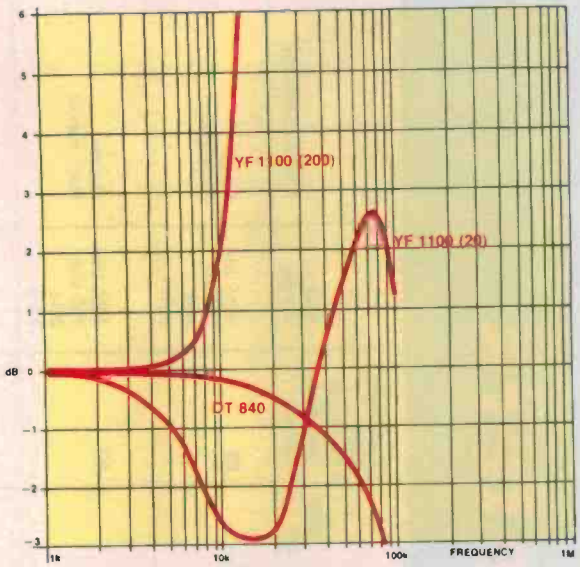
Numbers in brackets refer to range selected.

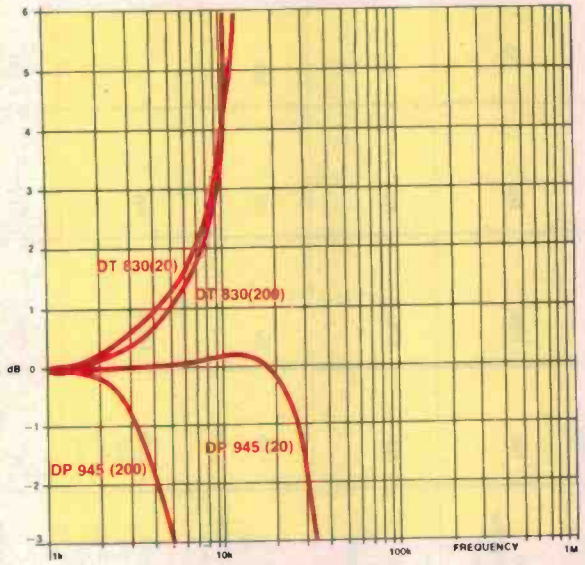


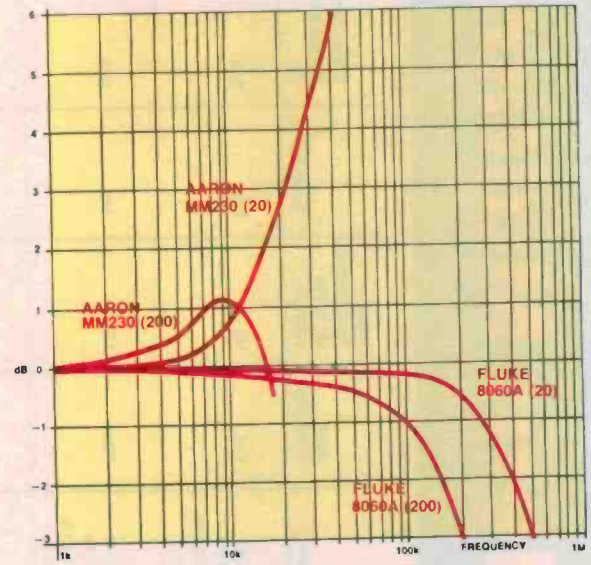
Frequence response of a typical analogue meter, the Avo 8. In order to give some sense of proportion to these graphs, we have included the response of the Avo 8, almost the industry standard in analogue multimeters.

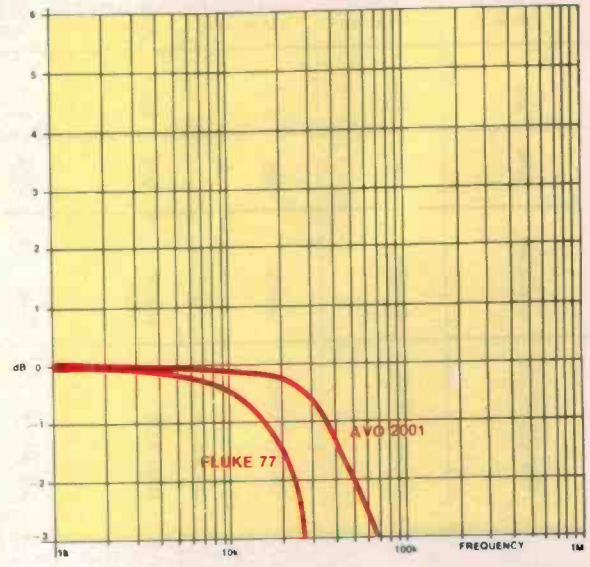


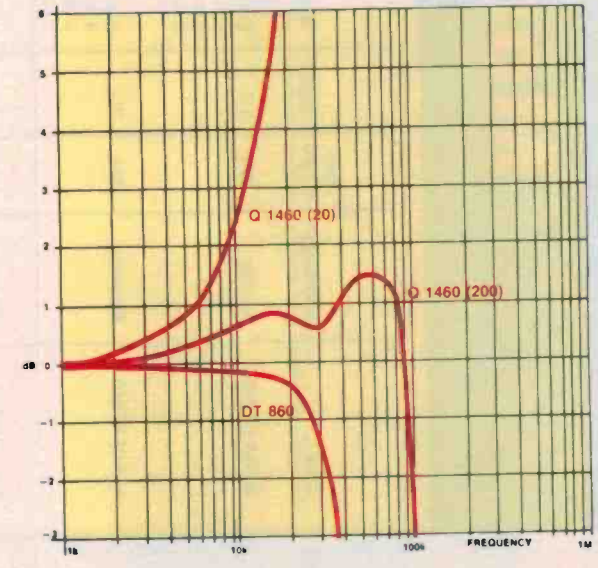

AARON
MM210 (200)
DP 935 (20)
DP 935 (200)
AARON
MM210 (20)
dB
FREQUENCY


YF 1100 (200)
YF 1100 (20)
DT 840
dB
FREQUENCY


DT 830(20)
DT 830(200)
DP 945 (20)
DP 945 (200)
dB
FREQUENCY


AARON
MM230 (20)
AARON
MM230 (200)
FLUKE
8060A (20)
FLUKE
8060A (200)
dB
FREQUENCY


AVO 2001
FLUKE 77
dB
FREQUENCY


Q 1460 (20)
Q 1460 (200)
DT 860
dB
FREQUENCY

Modern Multimeters

A selection of models, ranked in price order

Type	Distributor	Price (r.r.p.)	Digits	Ranges	Auto Ranging	Input Resistance dc volts (ohms)	True RMS	Measured Bandwidth Hz	CMRR dB	Continuity Test Maximum Resistance (ohms)	Max Range	Extras/comments
Univolt DT845A	Benelec	$54	3½	5 dc volts 4 ac volts 6 resistance 2 current	Yes	1G	No	30k	—	20	1000 Vdc 750 Vac 20M 10A	Buzzer Diode test
Univolt DT840	Benelec	$56	3½	5 dc volts 4 ac volts 6 resistance 1 current	Yes	1G	No	80k	—	20	1000 Vdc 750 Vac 20M 0.2 A	Buzzer Poor manual
Aaron MM210	Neotronics	$68	3½	5 dc volts 4 ac volts 6 resistance 5 current	On volts and ohms only	1G	No	28k	100	20	1000 Vdc 750 Vac 20M 10A	Diode test Buzzer
YuFung YF1100	University	$76	3½	5 volts 6 resistance 5 current	No	10M	No	11k	—	Not applicable	1000 Vdc 750 Vac 20M 10A	Transistor tester Diode tester
Univolt DT830	Benelec	$84	3½	5 volts 6 resistance 5 current	No	10M	No	9k	—	20	1000 Vdc 750 Vac 20M 10A	Buzzer Diode test Transistor tester
Univolt DT860	Benelec	$86	3½	5 dc volts 4 ac volts 6 resistance 3 current	Yes	1G	No	38k	—	20	1000 Vdc 750 Vac 20M 10A	Transistor tester
Hioki 3212	Nilson Rowe	$96	3½	5 dc volts 4 ac volts 5 resistance 2 current	Volts and ohms only	100M	No	—	—	—	1000 Vdc 600 Vac 2M 10A	Buzzer
CIE Q1460	DSE	$99	3½	5 volts 6 resistance 5 current 5 capacitance	No	10M	No	11k	100	Not applicable	1000 V 20M 10A 20μ	Touch hold Capacitance tester

Parameters 7040	**Parameters**	**$99**	**3½**	5 volts 6 resistance 6 current	**No**	**10M**	**No**	—	**<46 dB at 50 Hz**	Not applicable	1000 Vdc 750 Vac 20M 10A	Diode test
CIE 7905	Lamron	$102	3½	5 volts 6 resistance 4 current 5 capacitance	No	10M	No	10k	100	Not applicable	1000 Vdc 750 Vac 20M 10A 20μ	Capacitance tester
Hansen HD 50	University	$113	3½	5 dc volts 4 ac volts 6 resistance 5 current	Yes	—	No	—	—	20	1000 Vdc 750 Vac 20M 10A	Buzzer Diode test Poor manual
Aaron MM230	Neotronics	$114	3½	5 volts 6 resistance 5 current	On volts and ohms only	1G	No	17k	100	20	1000 Vdc 750 Vac 20M 10A	Buzzer Diode test
Hioki 3200	Nilson Rowe	$138	3½	5 dc volts 4 ac volts 6 resistance 5 current	Volts and ohms only	1G	No	—	—	—	1000 Vdc 750 Vac 20M 10A	Buzzer Push freeze
Avo 2001	Electrical Equipment	$184	3½	5 volts 6 resistance 6 current	No	10M	No	57k	—	<900	1000 V 20M 10A	Excellent probe kit Buzzer Diode test
Data Precision DP 935	Kenelec	$185	3½	5 volts 6 resistance 4 current	No	10M	No	10k	140	10% of range	1000 Vdc 700 Vac 20M 2A	Buzzer
Fluke 77	Elmeasco	$190	3½	4 volts 6 resistance 3 current	Yes	10M	No	25k	120	150	1000 Vdc 750 Vac 32M 10A	Analogue bar display Touch hold Diode test Buzzer
Kyoritsu 1003	Bell	$197	3½	5 volts 6 resistance 5 current	No	—	No	—	—	Not applicable	1000 Vdc 750 Vac 20M 2A	
Data Precision DP 945	Kenelec	$208	4½	5 volts 6 resistance 5 current	No	10M	No	5k	120	Not applicable	1000 Vdc 700 Vac 20M 2A	Excellent manual
Fluke 8060A	Elmeasco	$561	4½	5 volts 8 resistance 5 current 4 frequency	Resistance ranges only	80G	Yes	200k	120	10% of range	1000 Vdc 750 Vac 300M 2A 200 kHz	Frequency, dBm, dBr Diode test

The George Brown Electronics Group.

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TELEX 21732

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TELEX 62128

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PROTRONICS PTY LTD
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ADELAIDE 5000
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TELEX 88261

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VICTORIA PARK W A 6100
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TELEX 93883

Three new Fluke 70 Series Multimeters:

Champions of their class

With a great deal of pride, Fluke is now introducing the most revolutionary products in its history: the 70 Series Handheld Multimeters – the Fluke 73, 75, and 77.

These three 3½-digit instruments embody major breakthroughs in low-cost multimeter design. Selling for much less than other Fluke handheld models, the 70 Series offers unique and valuable features never before found in *any* multimeters, with no compromise in the Fluke tradition of quality, dependability, and value.

One innovation is the use of both analog and digital displays for the first time in a handheld multimeter. This combination provides both the accuracy of a digital display and the trend-monitoring advantage of analog meters.

The 70 Series Handheld Multimeters feature fast autoranging. After you select what you want to measure with the single rotary switch, the multimeter automatically chooses the best measurement range.

Another innovation of the 70 Series is the use of a 3200-count digital display. Compared to 2000-count DMMs, the new display gives the 70 Series the same resolution as a typical 4½-digit multimeter for readings that begin with digits between 20 and 32. For example, when measuring either a 24-volt dc power supply, a 220-volt ac power line, or a 20 milliamp current loop, the 3200-count display provides an extra digit of resolution.

Advanced CMOS circuitry allows for 2000 hours of battery life. And all three multimeters have a "sleep mode"; they automatically power down after about one hour of non-use, conserving power even further.

The Family

All of the Fluke 70 Series Multimeters measure dc voltage to 1000V, ac voltage to 750V, current to 10A, and resistance to 32 MΩ. You can choose the low-cost Fluke 73, the added features of the Fluke 75, or the deluxe Fluke 77. The Fluke 73 has a basic dc accuracy of 0.7%.

The Fluke 75 has all of the features of the Fluke 73 and better basic accuracy: 0.5%. In addition the Fluke 75 has a continuity beeper, two additional current ranges, and a choice of manual ranging as well as automatic ranging. Holding a range or manually selecting a range is sometimes convenient when comparing a succession of readings or observing bar graph trending.

The deluxe Fluke 77 has all of the features of the Fluke 75 and then some. Basic dc accuracy is 0.3% and this meter has the exclusive Fluke "Touch Hold" function (patent pending). This mode allows you to concentrate on careful placement of the test lead tips rather than the display. Especially useful in precise probing situations, this system automatically locks on to a stable reading, "beeps", and holds the value on the display even when the test leads are removed. Special software, specifically developed for this function, controls the meter, waiting until fluctuations in the value being measured have stabilized, then captures the measurement.

The Fluke 77 is sold as a complete package, including a new multipurpose holster. This holster functions as a protective cradle, a carrying case, a tilt stand, and, with the neck strap and belt clip, a means of holding and reading the meter while standing. The holster may also be purchased separately for the Fluke 73 and 75.

Fluke 73	Fluke 75	Fluke 77
$	$	$
Analog/digital display	Analog/digital display	Analog/digital display
Volts ohms 10A diode test	Volts ohms 10A mA diode test	Volts ohms 10A mA diode test
Autorange	Audible continuity	Audible continuity
0.7% basic dc accuracy	Autorange/range hold	Touch Hold function
2000 - hour battery life	0.5% basic dc accuracy	Autorange/range hold
3-year warranty	2000 - hour battery life	0.3% basic dc accuracy
	3-year warranty	2000 - hour battery life
		3-year warranty
		Multipurpose holster

FLUKE®

kind of thermocouple arrangement on the input, in which the input is allowed to heat an element and the meter then measures this heating effect.

An averaging meter, on the other hand, puts the ac into an ac-dc converter and then scales it up to give an RMS reading. This technique is quite legitimate so long as you are looking at a sinewave. There should be no difference between the two types of meter under these circumstances. As the input deviates more and more from the pure sine function, however, the differences between the two types become more and more apparent. According to Fluke Manufacturing, who produce many meters of both types, you can expect about a 1.4% error when measuring supply line ripple, 20% across a triac switching circuit and 29% from a transformer secondary. Of course, when we go to pulse trains and square waves with small duty cycles, the errors are much greater.

The problem is compounded by the fact that the more distorted the waveform, the more high frequency components will be present. A square wave, for instance, will have several harmonics, at least, of its fundamental frequency. To measure such a waveform properly the meter must respond to these harmonics. As a rule of thumb, you will get reasonable results if the DMM has a bandwidth five times greater than the fundamental frequency. All of which brings us to a consideration of bandwidth.

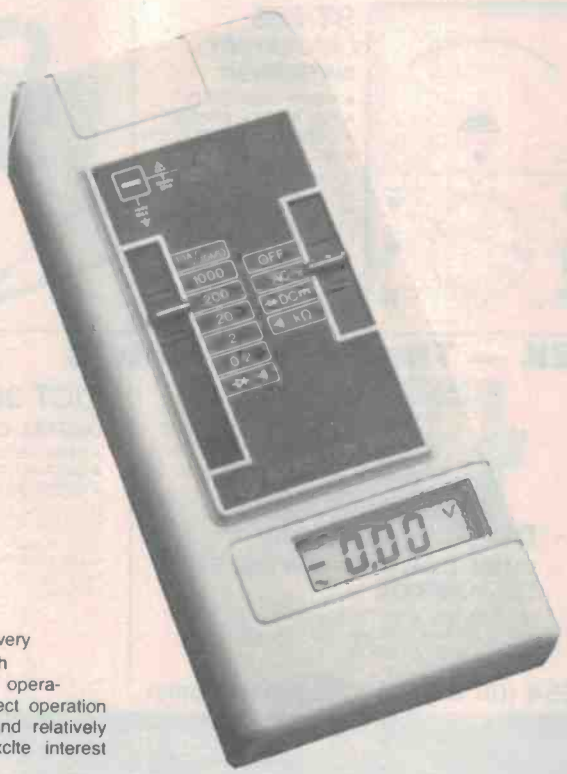
Out of interest, we had a look at the frequency response of the meters in our survey and compared them with one of the best known analogue multimeters, the AVO 8. In our sample, all the meters gave results of ±0.1 dB at 1 kHz. By 10 kHz some interesting differences had emerged and by the top of the audio range, say 20 kHz, some of the meters were reading in error by 3 dB. The Fluke 8060A and the Univolt DT840 were exceptional though, easily outperforming the AVO8.

Two general points emerged from this exercise. Firstly, handheld DMMs are not built for HF work. This is not really surprising, since if you were interested in working above about 10 kHz a CRO would be indispensible anyway. The second seems to be that, as a general rule of thumb, if you want to know when to treat a meter with suspicion, just change the range. If the reading changes by a significant amount then you are outside the 'safe' zone.

Environmental

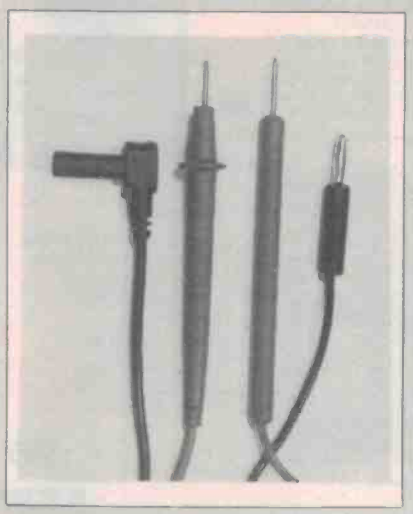
The final considerations in your hunt for the perfect multimeter are environmental ones. Consider first the electrical environment. The amount of electrical noise your multimeter can put up with is expressed as the *common-mode rejection ratio* (CMRR). Essentially, the CMRR measures the ability of the meter to reject inputs common to both probes of the meter. Typical values for CMRR should be about 100 dB at 50 Hz. This means the effect of common-mode signals on the output will be $1x10^{10}$ less than equivalent differential (wanted) voltages.

Finally, there is the physical environment



Avo 2001. One of the three DMMs available from Avo in this country courtesy of Electrical Equipment P/L of Sydney. It features very fast response time, in line sockets with a custom-built probe for single handed operation, and an audio warning of incorrect operation on the 10 A range. Although new and relatively unknown its name will probably excite interest even at $184.

PROBES



Guards and shrouds. Left to right: a shrouded plug, a probe with finger guard, a 'standard' probe and plug.

The probes that come with your meter are a very important part of the instrument. However, most people put them way down on the list of priorities when purchasing a meter. Manufacturers are well aware of this and, as a result, tend to go for the cheapest they can find, rather than those that will best complement the meter. There are a number of common faults. It's a good idea to be aware of them, especially when purchasing cheap meters.

The first point is a safety one — make sure the probe has a finger guard on it. The last thing you want is for your fingers to wind up wher the probe tip should be!

Another safety feature you should look out for is 'shrouded' plugs and sockets. This is especially relevant if you need to continually change sockets on the DMM to change the measuring function. Ideally, both the plug and socket should be constructed so that it is impossible for the operator's fingers to come into contact with any bare metal. Many modern meters come with plugs and sockets that fit inside a shroud, thus ensuring plastic meets plastic before metal comes into contact with metal.

It's also worth looking at the method used to secure the lead to the plug. Because the leads have a very hard life, being continually twisted and pulled, a lot of stress is placed on the joint between the lead and plug. Make sure the plug shroud fits tightly over the lead so as to minimise the amount of movement at the joint.

It is possible to get leads in which the plug is bonded to the lead so no movement is possible. In theory, nothing should ever go wrong with this type, but if it does you'll just have to buy a new one.

A further, very handy, thing to look for is the provision of some kind of hook option with the probe so that you can connect it to the circuit without holding it. It's particularly useful to be able to hook the negative of the meter to circuit ground when doing voltage checks. Unfortunately, very few of the meters we looked at had this option. Of course, when all else fails you can buy an alligator clip and a bit of lead and make one up for yourself.

MULTIMETERS GALORE!

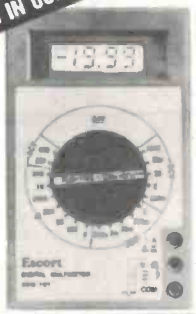
IF IT IS NOT ON THIS PAGE IT IS IN OUR CATALOGUE

ESCORT RANGE (As used extensively by NSW Dept. of TAFE)

EDM-101

- GOLD PLATED ROTARY SWITCH
- 3½ DIGIT LCD DISPLAY
- AUTO POLARITY CHANGE
- CARRY CASE

VDC 0.2-1000V (±0.8%)
VAC 0.2-1000V (±1.2%)
ADC 200µA-2A (±1.0%)
Ohm 200-20M (±1.0%)



$47

EDM-201

- PRECISION RESIS. NETWORK
- ZENER DIODE, 2A FUSE, PTC
- CARRY CASE

VDC 0.2-1000V (±0.5%)
VAC 0.2-1000V (±1.0%)
ADC 200µA-10A (±0.75%)
AAC 200µA-10A (±1.25%)
Ohm 200-20M (±0.5%)

$59

EDM-302

- HIGH ACCURACY
- CRYSTAL OSCILLATORS
- CONTINUITY TEST BUZZER
- CARRY CASE

VDC 0.2-1000V (±0.25%)
VAC 0.2-1000V (±0.75%)
ADC 200µA-10A (±0.5%)
AAC 200µA-10A (±1.0%)
Ohm 200-20M (±0.25%)

$79

AKIGAWA RANGE — The Japanese Technology

AD-800

- AUTO/MANUAL RANGING
- 3½ DIGIT LCD DISPLAY
- FUSE PROTECTION
- CONTINUITY TEST BUZZER

VDC 0.2-1000V (±0.35%)
VAC 2-750V (±1.0%)
ADC 200µA-10A (±1.0%)
AAC 200µA-10A (±1.2%)
Ohm 200-20M (±0.7%)

$95

AD-901

- AUTOMATIC RANGING
- 3½ DIGIT LCD DISPLAY
- OVER-RANGE INDICATION
- FUSE PROTECTION
- CONTINUITY TEST BUZZER

VDC 0.2-1000V (±0.5%)
VAC 2-750V (±1.0%)
ADC 200µA-10A (±1.2%)
AAC 200µA-10A (±1.5%)
Ohm 200-20M (±0.8%)

$78

L-224

- TAUT BAND MOVEMENT
- FULL AC AMPS RANGE
- POCKET SIZE
- TEMPERATURE RANGE
- CARRY CASE

VDC 0-1000V
VAC 0-1000V
ADC 0-10A
AAC 0-10A
Ohm: Rx1, Rx10, Rx100
0.5-5M
dB: −20-+62 dB
Other functions:
Load current, Battery.

$42

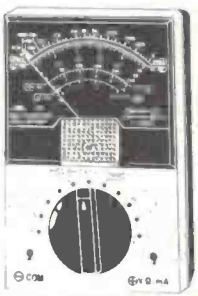
SEW RANGE — The Popular Brand

ST-5

MINI TESTER

- 4 KΩ/V SENSITIVITY
- POCKET SIZE

VDC 0-500V
VAC 0-1000V
ADC 0-250µ. 250m
dB −10-+22 dB
Dim: 60x90x34mm



$12

ST-350

SOLID PERFORMER

- MIRROR SCALE
- UP TO 10A DC
- 2kΩ/V SENSITIVITY

VDC 0-1000V
VAC 0-1000V
ADC 0-10A
Ohm: Rx1, Rx10, Rx1k
dB: −20-+36 dB
Capacitance: 100pF — 0.03µF
Inductance 10-1000H

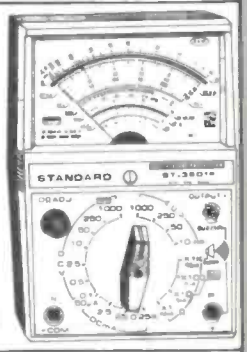
$21

ST-380TR

BUILT IN BUZZER

- TRANSISTOR CHECKER
- MIRROR SCALE
- FUSE & DIODE PROTECTION
- 20kΩ/V SENSITIVITY

VDC 0-1000V
VAC 0-1000V
ADC 0-250M
Ohm: Rx1, Rx10, Rx100, Rx1k
dB: −10-+50 dB



$29

ST-320

TAUT BAND MOVEMENT

- ALL PURPOSE MULTIMETER
- FUSE & DIODE PROTECTION
- DROP PROOF

VDC 0-1000V
VAC 0-1000V
ADC 0-300mA
Ohm Rx1, Rx10, Rx1k
Battery test: 1.5V (under load)
Temp range: −50°C-+150°C

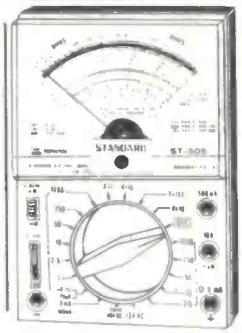
$27

ST-505

LABORATORY INSTRUMENT

- 50kΩ/V SENSITIVITY
- 10A, AC & DC RANGES
- OVERLOAD PROTECTION
- SHOCK PROOF

VDC 0-1000V
AVAC 0-1000V
ADC 0-10A
AAC 0-10A
Ohm: Rx1, Rx10, Rx100, Rx1k
dB: −20-+62 dB



$45

ST-300

RUGGED CLAMPTESTER

- SHOCK PROOF
- FUSE PROTECTION
- POINTER STOPPER
- CARRY CASE

VAC: 0-150, 300, 600V
AAC: 0-6, 15, 60, 150, 300V
Ohms: 0-1kΩ

$54

EMTEK — The Special Meters

DCM-100

CAPACITANCE METER

- 3½ DIGIT LCD DISPLAY
- WIDE TEST RANGE
- X-TAL TIME BASE ACCURACY

Range: 200pF-2000µF (±0.5%)
Max Resolution: 0.1pF
Calibration adjustments.
- Front panel zero adj.
- Internal calibration adj.

Protected against charged capacitors.

$99

DP-96 PANEL METERS

LARGE DISPLAY — LOW POWER CONSUMPTION

VOLTS: 1.999, 19.99, 199.9, 1000-AC/DC
AMPS: 199.9µA, 1.999mA, 19.99mA, 199.9mA 1.99A, 10A-AC/DC

$54 (DC Supply) **$59 (AC Supply)**

DCT 300

DIGITAL CLAMP METER

- PEAK HOLD
- DATA HOLD
- OVERLOAD CIRCUIT

VDC 0.2V-1kV (±0.5%)
VAC 200V, 750V (±1%)
AAC 20A-600A (±1.5%)
Resistance: 200Ω-2MΩ
Diode check & temperature functions.

$95

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Hioki 3212. A 3½-digit DMM with autoranging on the volts and resistance ranges. It features a 100M input resistance. Nilson Rowe distribute the Hioki range.

in which the meter will be used. Although it is probably the last thing to be thought about when buying a meter, the physical construction of the unit is probably the area where manufacturers can make their biggest price saving.

There is often a real trade-off between price and the rigidity of the case. It needs to be said, however, that this is not a universal rule. Some of the cheapest units we tested gave us the appearance of great robustness. On the other hand some quite expensive meters looked very flimsy.

In the normal course of things this doesn't matter much. A laboratory bench is, or ought to be, a fairly 'kind' environment for electronic gear. If you intend using it in a garage, or at sea, or in a construction site, think about the unit's ability to withstand wear and tear. How easy will it be for spray to penetrate to the pc board? Could it withstand a two-storey fall? (Or even a two metre fall).

The final choice is up to you. It's worthwhile to consider carefully though, and not to be overly influenced by 'specials' and the prospect of saving a few dollars. Remember that your meter will probably be around for many years. And bear in mind that the biggest problem with meters is the occasional short circuit between the ears of the user!

Distributors Index

1. Arlec. 42 Lexton Rd, Box Hill, Vic. 3128. (03) 840-1222. They are mainly involved in selling a range of analogue meters. Their only DMM is the YF 1020.

2. AWA. 422 Lane Cove Rd, Macquarie Park, North Ryde, NSW 2113. (02) 887-7111. AWA distribute only one DMM on the Australian market, the DM500. It's a 3½-digit handheld machine with 1000 volts ac as well as dc. The recommended retail price is $84.

3. Benelec. 1 Greville St, Randwick, NSW 2031. (02) 665-8211. Distributors of the Univolt range.

4. Bell Instruments. 55 Garema Circuit, Kingsgrove, NSW 2208. (02) 750-6000. Bell sell and distribute an extensive range of instruments but only one DMM, the Kyoritsu 1003.

5. Dindima. 10 Argent Place, Ringwood, Vic. 3134. (03) 873-4455. Distribute a variety of instruments including the Arlunya range of DMMs.

6. Emona. 208 George St, Sydney, NSW 2000. (02) 212-4815. Emona sell a wide range of DMMs on the east coast and are represented by Radio Parts further west. They handle the Akigawa, Escort and Emtek brands.

7. Elmeasco. 15 Macdonald St, Mortlake, NSW 2137. (02) 736-2888. Primary distributors for Fluke Instruments of the US. Fluke make a wide range of bench and handheld instruments. They claim the series 70, at the bottom of their price range, is the best selling of the lot. ▶

Modern Multimeters

Distributors Index Con't

8. Hewlett-Packard. 17 Talavera Rd, North Ryde, NSW 2113. (02) 887-1611. The local branch of the overseas giant. In the DMM stakes they're very upmarket. Their cheapest meter is the 3455 3½-digit machine, selling for $839, and it goes up from there. The top of the range is the 3456A selling for $5295. Of course, it comes with all kinds of intelligent features and mathematical functions. One interesting model is the 3468 which can be interfaced with that great friend of the engineering student, the HP41C calculator.

9. Electrical Equipment. 33 Belona Ave, Regents Park, NSW 2143. (02) 517-1155. Their Measurement and Control Division distributes the British Avo meters in Australia. Avo is now part of the Thorn EMI group. Included in the range are the Avo 2000 and Avo 2001 DMMs and the B183 digital reactance meter.

10. Kenelec. 48 Henderson Rd, Clayton, Vic. 3168. (03) 560-1011. Distributors of a wide range of DMMs from Data Precision, including the 935 and 945 reviewed here. There are 19 models ranging in price from $160 to $685.

11. Kent Industries. 70 Box Rd, Caringbah, NSW 2229. (02) 525-2811. They distribute the well respected Beckman Instruments including the 3½-digit DMMs ranging between $200 and $415.

12. Lamron. P.O. Box 338, Ryde, NSW 2112. (02) 85-6228. Distributors of 20 types of CIE meters to suit pockets holding $84 to $285.

13. Lawrence and Hansen. 102 Derby St, Silverwater, NSW 2141. (02) 648-4011. Distributors for Soar. They don't have any handheld DMMs, but Soar produce a number of bench-top models amongst their other instruments.

14. Nilsen Rowe. 200 Berkley St, Carlton, Vic. 3053. (03) 347-9166. They handle the Hioki range of meters, which sell for around the $100 mark. They also have the Hioki 3208 meter in stock, which combines DMM functions with that of a calculator.

15. Neotronics. P.O. Box 289, Newport, NSW 2106. (02) 918-8220. They distribute for Aaron, best known for their fine range of CROs. The also make a small range of handheld DMMs, including those mentioned in the table.

16. Non Linear Systems. 41 Kinnouli Grove, Glen Waverley, Melbourne, Vic. 3000. (03) 232-4506. Best known for their analogue and digital panel meters. They also sell a small number of DMM's under the house brand.

17. Parameters. 53 Governor St, Mordialloc, Vic. 3195. (03) 580-7444. One of the bigger electronic distributors. Parameters sell DMMs under a house brand. See elsewhere for description of their Model 7040.

18. Rohde & Schwarz. 13 Wentworth Avenue, Darlinghurst, NSW 2010. (02) 267-2622. Their entry into the DMM stakes is the UDS 5 from West Germany. It's a high quality laboratory bench-type 5½-digit unit that will set you back $1750 plus tax.

19. Ronan Engineering. 32 Chandos St, St. Leonards, NSW 2090. (02) 438-3562. Primarily process and industrial applications engineers, but they sell a number of specialist instruments for temperature reference, etc. and a 4½-digit calibrator with 10 V, 100mA and 1k ranges.

20. Scientific Devices. 2 Jacks Road, South Oakleigh, Vic. 3167. (03) 579-3622. Distribute a range of high quality bench DMMs for Kelthley, a US-based manufacturer.

21. Tech Rentals. 88 Wellington St, Windsor, Vic 3181. (03) 51-1303. They also trade as Tech Sales. The company handles Solartron and Schlumbeger meters for the high quality end of the market. They recently took over Elmeasco.

22. Technico Electronics. 67 Mars Rd, Lane Cove, NSW 2066. (02) 427-3444. They sell meters for Simpson with various models between $150 and $400.

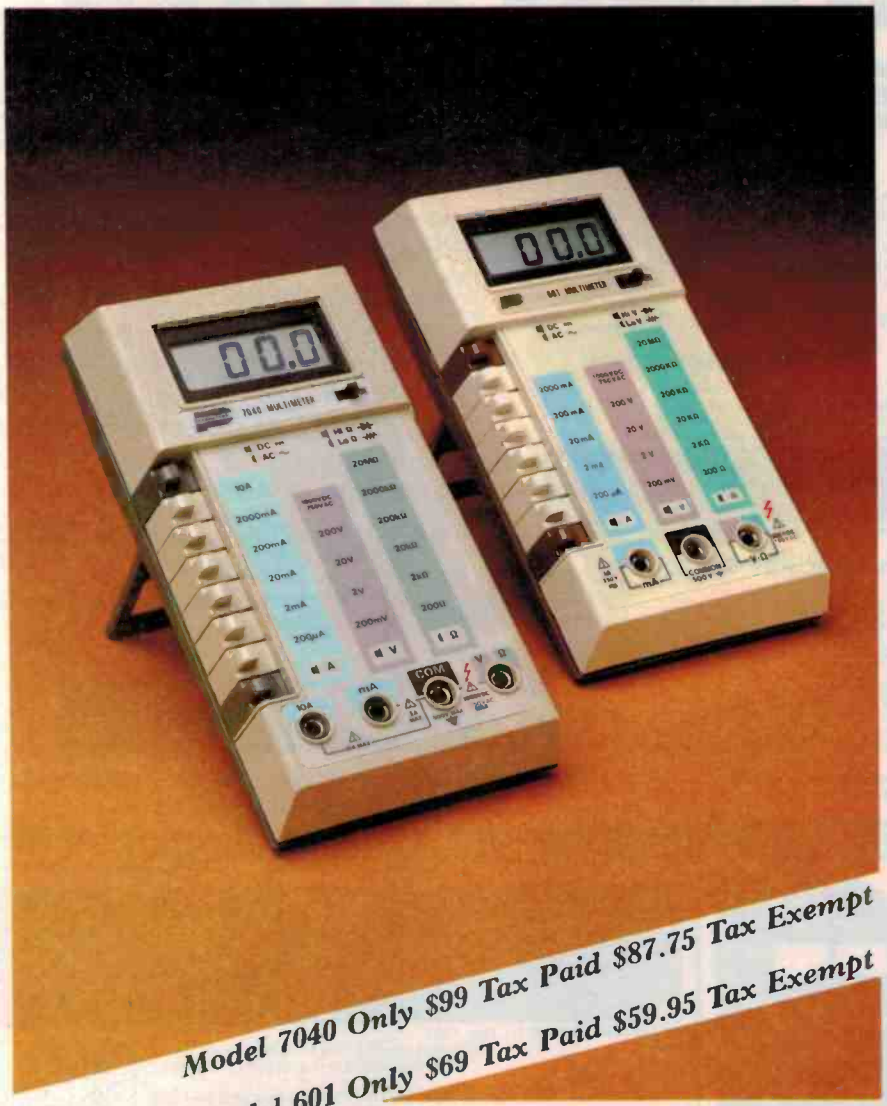
23. University Graham. 106 Belmore Rd, Riverwood, NSW 2210. (02) 53-0644. This well known instrument making and distribution company sells a wide range of DMMs. Included are Hansen and YFE, but often they sell with house brands on the meter.

24. Vicom. 57 City Rd, South Melbourne, Vic. 3202. (03) 62-6931. They handle Global Specialties, the US-based Instrument makers. They specialize in Bench DMMs and other instruments.

25. Warburton Franki. P.O. Box 182, Chatswood, NSW 2067. (02) 648-1711. Well known in the instrumentation field, Warburton Franki sell a number of meters. Included in the lower end of the market is the Beckman range of 3½-digit DMMs selling between $200 and $415.

26. Warsash. P.O. Box 217, Double Bay, NSW 2028. (02) 30-6815. Sells a powerful DMM called the HEME 1000 that specialised in measuring very high current. ●

Undisputably your best buy in DMM's



Here's your chance to own a Parameters Model 7040 or Model 601 digital multimeter, probably the best value instruments of their type in Australia. Instruments that are widely respected for their proven quality, ruggedness, dependability, accuracy and style.

Features

- 3½ digits
- 28 ranges
- Basic DCV accuracy 0.1% (7040) and 0.25% (601)
- Battery Life >2,000 (7040) hours and >200 hours (601)
- Hi-Lo Volt resistance tests
- Overload Protection on all ranges
- Current ranges 10A (7040) and 2A (601)
- Auto polarity
- Finger guards on probes and shrouded plugs for safety
- Low battery indicator
- Quality leads and Probes included

Our No-Nonsense Warranty

You have the full protection of our no-nonsense warranty for a full 12 months from the date of purchase. Should your instrument develop a fault not attributable to physical abuse, simply return it to us freight paid and we will either repair or replace it at no charge to you. This applies in addition to all warranty requirements you normally receive under the trade practices act.

All prices include delivery anywhere in Australia

ORDER NOW
and receive a bonus vinyl carrying case (normally $12.00)

ORDER FORM

I would like to take advantage of your special digital multimeter offer. Please supply me meter(s) as set out below. I understand that I will receive a carrying case for each meter ordered at no extra charge.

QTY.	MODEL	PRICE TAX* FREE	PRICE TAX PAID	TOTAL AMOUNT
	601	$59.95	$69.00	$
	7040	$87.75	$99.00	$
				$

* Tax free orders must include an exemption certificate on an official company order.
** Bankcard users be sure to include your full home address, not a PO box number.

PLEASE ALLOW 7 DAYS FOR DELIVERY

NAME .....

ADDRESS .....

.....

☐ I enclose my cheque for $ .....
☐ Please charge my Bankcard **
No. 496 ___ ___ ___ ___ ___ ___ ___ ___
☐ Our Company Order No. ..... is enclosed

SIGNATURE .....

PARAMETERS
PERFECTION IN MEASUREMENT

Detach and return to:
Parameters Pty. Ltd. P.O. Box 573 ARTARMON N.S.W. 2064 Offer closes June 30, 1984

Sydney: 41 Herbert St., Artarmon, N.S.W. 2064. Phone: (02) 439 3288 Melbourne: 53 Governor Rd., Mordialloc, Vic. 3195. Phone: (03) 580 7444

xypar 397

RIR SERIES 5000

PRICES SLASHED

As designed by ETI

INDIVIDUAL COMPONENTS TO MAKE UP A SUPERB HI-FI SYSTEM. BY DIRECTLY IMPORTING AND A MORE TECHNICALLY ORIENTED ORGANISATION BRING THESE PRODUCTS TO YOU AT LOWER PRICES THAN OUR COMPETITORS.

EXTRA FEATURES OF OUR KITS

POWER AMPLIFIER

KIT PRICE $319 P&P $12.00 — **Only $449**

• 1% Metal Film Resistors are used where possible • Prewound Coils are supplied • Aluminium case as per the original article • All components are top quality • Over 400 Kits now sold • We have built this unit and so know what needs to go into every kit • SUPER FINISH Front panel supplied with every kit at no extra cost to you. • We are so confident of this kit that we can now offer it assembled and tested so that people who do not have the time can appreciate the sound that this amplifier puts out. This is done on a per order basis delivery approx. four weeks after placement.

PREAMPLIFIER

KIT PRICE $289 P&P $12.00 — **Only $449**

• 1% Metal Film Resistors are supplied • 14 metres of Low Capacitance Shielded are supplied (a bit extra in case of mistakes) • English "Lorlin" Switches are supplied no substitutes as others supply • We have built and tested this unit and so know what needs to go into every kit • Specially imported black anodised aluminium knobs • Again as with the power amp we are offering this kit A & T at a price which we do not believe there is a commercial unit available that sounds as good. Same delivery as the PA.

PREAMPLIFIER Kit Price $289, P&P $12.00

SPECIFICATIONS

Frequency response:	High-level input: 15Hz-130 kHz, +0, −1 db Low-level input — conforms to RIAA equalisation, ±0.2 dB
Distortion:	1kHz <0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation).
S/N noise:	High-level input, master full, with respect to 300 mV input signal at full output (1.2V): >92 dB flat >100 dB A-weighted. MM input, master full, with respect to full output (1.2V) at 5 mV input, 50 ohm source resistance connected: >86 dB flat >92 dB A-weighted. MC input, master full, with respect to full output (1.2V) and 200 μV input signal: >71 dB flat >75 dB A-weighted.

On Special at $259
Normally $289

**All parts available separately for both kits.*

POWER AMPLIFIER Kit Price $319, P&P $12.00

SPECIFICATIONS 150W RMS Into 40hms

Power output:	100W RMS into 8 ohms (±55 V supply).
Frequency response:	8 Hz to 20 kHz, +0−0.4 dB 2.8-Hz to 65 kHz, +0−3 dB. NOTE: These figures are determined solely by passive filters.
Input sensitivity:	1V RMS for 100W output.
Hum:	−100dB below full output (flat).
Noise:	−116 dB below full output (flat, 20 kHz bandwidth).
2nd harmonic distortion:	<0.001% at 1 kHz (0.0007% on prototypes) at 100 W output using a ±56 V supply rated at 4 A continuous. <0.003% at 10 kHz and 100 W.
3rd harmonic distortion:	<0.0003% for all frequencies less than 10 kHz and all powers below clipping.
Total harmonic distortion:	Determined by 2nd harmonic distortion (see above).
Intermodulation distortion:	<0.003% at 100 W. (50 Hz and 7 kHz mixed 4:1).
Stability:	Unconditional

Please note that the "Superb Quality" Heatsink for the power amp was designed and developed by Rod Irving Electronics and is being supplied to other kit suppliers. This product cost $1,200 to develop so that your amplifier kit would have a professional finish as well as sound.

On Special at $299
Normally $319

MX-1200 MICROPHONE/AUDIO MIXER

This unit features: 12 microphone line inputs with pan, bass, treble, effect and fold back controls for each channel • LED peak indicators for each channel • 2 turntable inputs with cross-fade and individual output controls • master equaliser for bass, midrange and treble • variable headphone output etc. etc • complete with carrying case.

SPECIFICATIONS:

INPUTS
Level/Impedance Mic .46 db/1K
Line .22 db/16K ± 12
Phono .52 db/50K STEREO ± 2 (2mv) at 1KHz
Effect Return (Aux) .20 db/50K ± 1
OUTPUTS
Level/Impedance L & R 0 db/2K
Effect Send 0 db/2K F/B Out 0 db/2K
Head phone Stereo +10 db/600 (100 1K)
EQUALISATION
Channel
Bass ± 15db
Treble ± 15db
Master
Bass ± 12db
Treble ± 10db
Middle ± 12db

FADER & CONTROLLERS
12 channel fader: Slide, 60mm, LOG 25%
2 Master fader: Slide, 60mm, LOG 15%
12 F/B Volume, 300, LIN
1 F/B Master level, 300, LIN
12 Effect Send, 300, LIN
1 Effect Return, 300, LOG 15%
2 Phono, 300, LOG 15%
1 Head Phone, 300, LOG 15%
S/N: 58DB
FREQUENCY RESPONSE: 20-20 KHz
TOTAL HARMONIC DISTORTION: Less than 0.1%
METER: 2 illuminated VU Meters 0db = 0.775V
PEAK INDICATOR: 12 LED Peak Indicators
VOLTAGE: 240 VAL 50Hz
POWER CONSUMPTION: 7.2 watts
DIMENSIONS: 520 (W) × 386 (D) × 108 (H) mm (supplied complete with carrying case)

THIRD OCTAVE GRAPHIC EQUALIZER

SPECIFICATIONS E.T.I. Dec. 1982

Bands:	28 Bands from 31.5 Hz to 16 kHz
Noise: 20 kHz bandwidth	<0.008 mV, sliders at 0, gain at 0 (−102 dB).
Distortion:	0.007% at 300 mV signal, sliders at 0, gain at 0; max. 0.01%, sliders at minimum.
Frequency Response:	12 Hz-105 kHz, +0, −1 dB, all controls flat.
Boost & Cut:	14 dB

$195.00 1 Unit
$379.00 2 Units

SERIES 4000 SPEAKERS.

- 8 speakers with crossovers $499
- Speaker boxes (assembled with grill and speaker cutout) $299
- Crossover kits $199
- Complete kit of parts (speakers, crossovers, screws, inner-band boxes) $799
- Assembled, tested, ready to be hooked up to your system $849

WE BELIEVE THAT WE ARE NOW THE ONLY ONES TO SUPPLY COMPLETE SPEAKER KITS ASSEMBLED AND TESTED FOR THOSE WHO HAVEN'T GOT TIME $849 EX STOCK.

PLEASE WRITE FOR CONSTRUCTION NOTES, THESE COMPLIMENT THE SERIES 5000 AMP RANGE AND ADD THE FINAL TOUCH.

ROD IRVING ELECTRONICS

425 High St., Northcote, Vic. 48-50 A'Beckett St., Melb., Vic.
Phone (03) 489 8866, (03) 489 8131, Mail Order Hotline (03) 481 1436
Mail orders to P.O. Box 235 Northcote 3070 Vic.
Minimum P & P $3.00. Errors & omissions excepted.

Please address tax exempt, school, wholesale, and dealer enquiries to:
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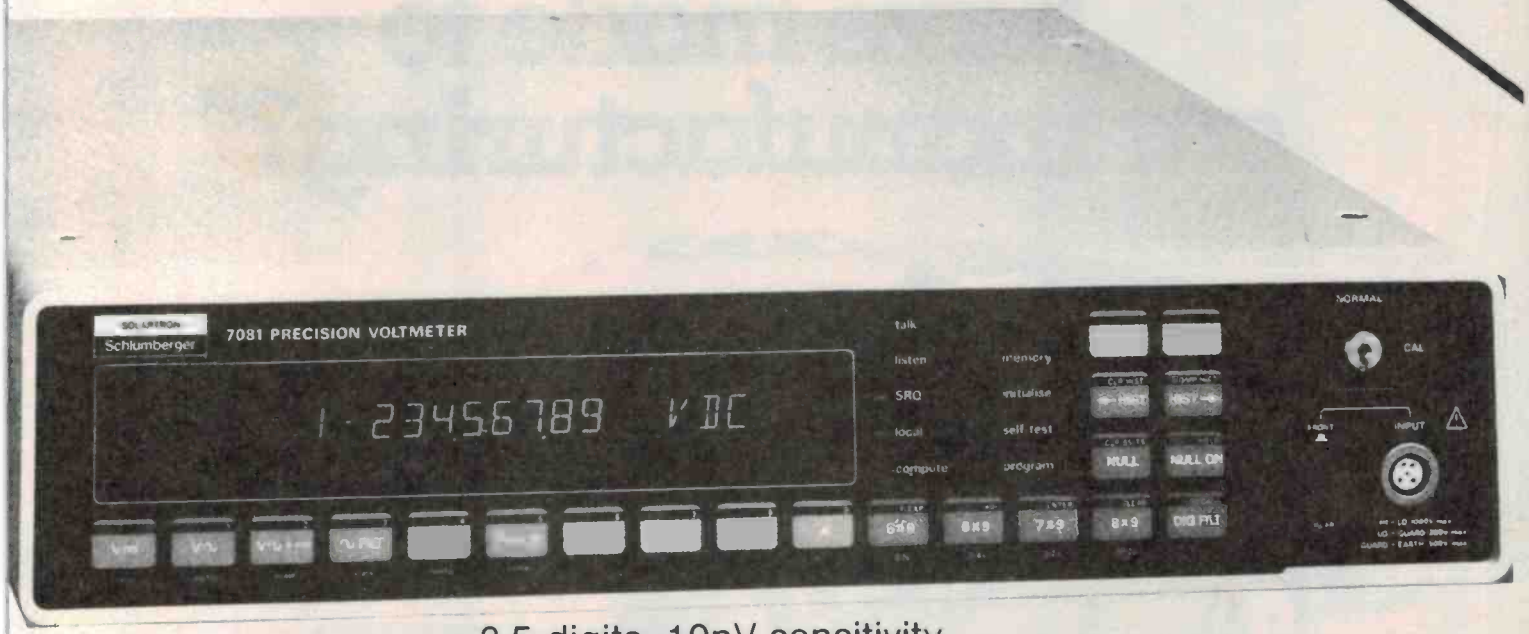
1st floor 425 High St. Northcote 3070 (03) 489 7099 (03) 481 1923
Telex AA 38897

Solartron
INSTRUMENTATION GROUP

NEW
7081 PRECISION VOLTMETER



- 8.5 digits, 10nV sensitivity
- 1.2 ppm stability 24 hours
- 11 ppm uncertainty 1 year
- True RMS AC
- Resistance to 1000 Mohm
- Comprehensive processing
- Variable integration
- IEEE488 and RS232 interfaces

7081 – the most advanced voltmeter in the World. The voltmeter that provides less measurement uncertainty and better stability than any other product. The first with 8½ digit scale length that gives a fantastic 10nV sensitivity. This, coupled with various methods of digital filtering, enables measurements to be made that have not been possible in the past. Add to this comprehensive result processing, a history file, and full control via RS232 or IEEE488 interfaces means a product that cannot fail to meet the requirements of standards laboratory and automatic test, yet is still appropriate for straightforward bench use.

Contact your nearest Tech Sales office for a full brochure and specifications.

Tech-Sales

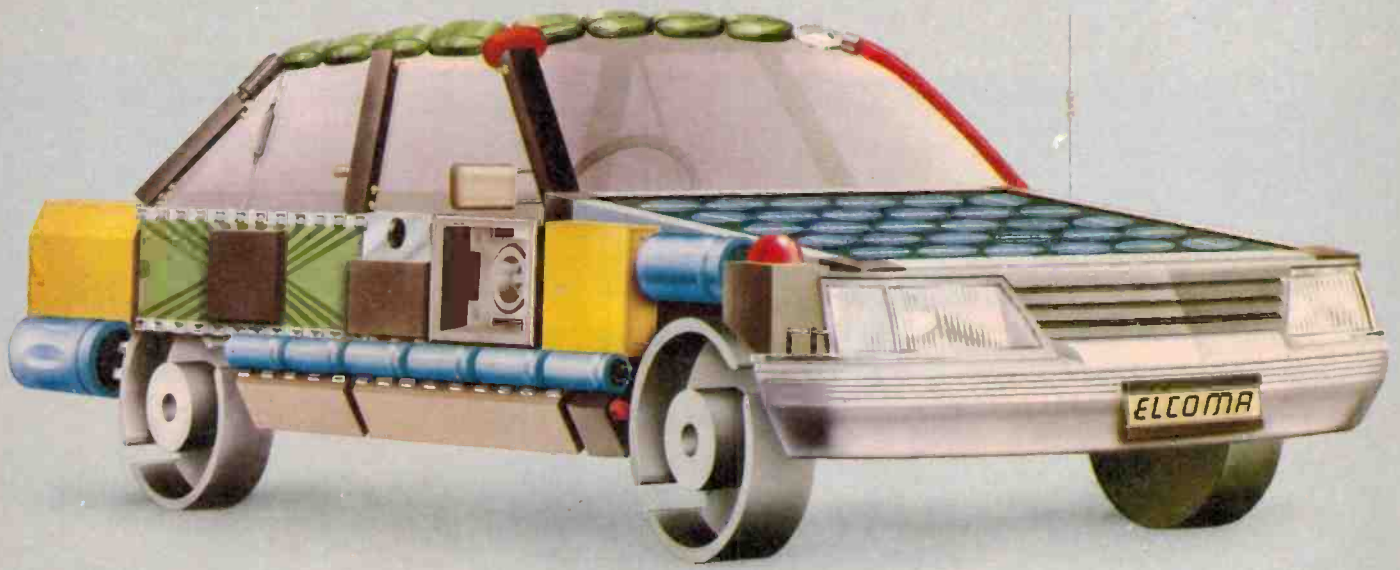
TECH–SALES PTY. LTD. (Inc. in Victoria)

12 Maroondah Highway,
Ringwood, Vic., 3134.
Telephone: (03) 879 2733
Telex: AA30418

Zurich House
55 Blaxland Road,
Ryde, N.S.W. 2112.
Telephone: (02) 808 3055
Telex: AA71939

Scott House
46-48 Kings Park Road,
West Perth 6005.
Telephone: (09) 322 1085
Telex: AA94765

"Can you see the changes Philips Components have made to car manufacturing?"



For something that has so radically changed our lifestyle, the motor car has undergone few really fundamental changes. Its faithful reciprocating combustion engine, for example, is mechanically the same as it was when man was first learning to fly.

Yet one true automotive breakthrough has been the application of modern electronics. Fuel injection systems that "read" the supply, the load and adjust to the demand. Engine management systems that continually monitor and rectify. Consoles that "speak up" about anything from brake failure to seatbelts not fastened.

And while it's true we once got by without this much help, it's amazing how quickly we come to rely on it. Which soon makes products without advanced electronics seem like something's missing.

As a car manufacturer or any "other" manufacturer, there's every chance your products or processes are already affected by the application of this modern technology. Or soon could be. So whether you do it first or second could have a lot to do with what you do next.

Talk with the people who make electronics in Australia... Philips Elcoma. Find out the newest technology applicable to your products and processes, from our worldwide access. The results may surprise you.

Call Philips Components to discuss the changes you have in mind to your manufacturing technique:

Sydney **427 0888.** Melbourne **542 3333.**
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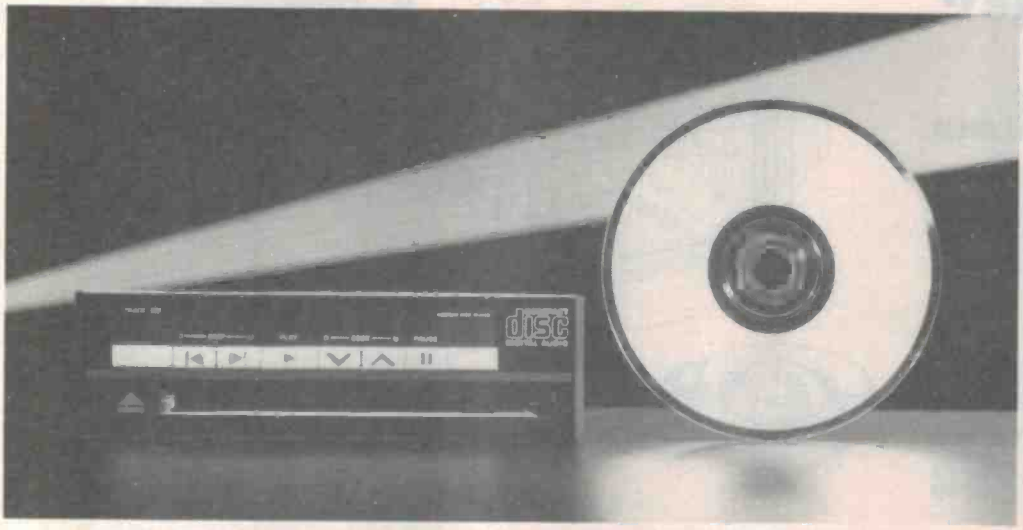


Compact disc players take to the road

Laser technology, which revolutionised hi-fi equipment with the compact disc player, will be introduced into car audio later this year when National launches its compact disc player for car audio.

Putting a compact disc player on the road wasn't an easy task. National was faced with several special problems. First, a car CD player has to be small enough to fit easily into limited dashboard space. Second, it has to be able to endure the bumps and jolts encountered on the road. Third, it has to operate on a low voltage power source. Finally, it has to be impervious to interference from other electrical equipment.

National car audio engineers solved these problems by developing a car audio CD player with simple operation, shock and vibration resistant structure and minimal size. National's CD player is designed so that the disc operates horizontally — the angle which best minimises road vibration and shock. The objective lens is mounted upside-down so that dust won't accumulate on it. The laser stylus and spindle motor are small enough to fit into a 50 mm high chassis.

However, the most important feature to the driver is that the National car audio CD player is so easy to operate. The front panel has an LED display that gives information on all major functions at a glance. The driver's eyes can stay where they belong — on the road.

Disc loading is super simple. Just slide the disc into the loading slot and it's automatically pulled into the deck and loaded. Power is automatically switched on. There's no need to press a play key. All operations, such as eject, pause, seek up and seek down are controlled by four convenient key switches.

Now it's up to car manufacturers to reduce the ambient noise level inside cars so that it will be possible to fully appreciate the increased dynamic range available from CD players.

A release date for National's car compact disc player is yet to be announced. For more information contact National Panasonic (Aust.) Pty Ltd, 95 Epping Rd, Nth Ryde NSW 2113. (02)887-5333.

Make yourself heard!

Sydney-based distributor, Benelec Pty Ltd, stocks what is probably the most comprehensive range of public address and communications speakers available here, with over a dozen types in the range.

Sizes and power ratings range from a compact 88 mm (3.6") diameter model (catalogue number 8-203) rated at 4 W maximum, to a monster 305 mm (12") diameter diameter model (8-212) rated at 50 W maximum.

The model 8-106 is a compact communications speaker designed for mobile applications in vehicles or boats. It measures just 55 mm in diameter and offers a frequency response of 450 Hz to 4.5 kHz, just right for good communications intelligibility.

Benelec offers a number of popular 5" PA horns. Of special interest is their 8-205F, a 'foreshortened' model about half the length of their other 5" models, for installation where length is an important consideration. Performance is not compromised, however, and it can be expected to deliver in excess of 90 dB sound pressure level, the company claims.

For complete details on the range of PA and communications speaker, contact **Benelec** at **P.O. Box 21, Bondi Beach NSW 2016. (02)665-8211.**

Electronic cameras

The last ten years have seen the decimation of the Super 8 mm cine market, as video cameras and recorders have become more accessible to the general public. It has been predicted for quite some time that the same thing was all set to happen on the still picture market.

But now comes news that the market leader in the field, Sony, may be having a rethink about the technology, and the timing of its release.

Sony introduced a camera in 1981, called the Mavica, that was advertised as a working prototype of a consumer electronic camera.

International Resource Development Inc, a market research organisation, has just completed a report on the revolutionary camera. It seems that Sony has run into more problems than expected in turning the Mavica into a viable consumer item. It also seems to be rethinking its strategy of releasing the product directly onto the consumer market.

The report suggests Sony is looking at an industrial release within the next few years. The consumer market will be supplied by post Mavica-type technology, but that may be years away.

Gruve-glide

This easy-to-apply 'dry' cleaning treatment for records is claimed to improve stylus tracking of record grooves, clean and de-stat records and produce demonstrably improved sound from records.

Gruve-Glide is an aerosol spray lubricant which comes with two applicator pads. Application is as simple as spraying the solution onto one of the pads and then treating the record in a circular motion until the surface is smooth and shiny.

A single treatment will last for at least 50 plays before a second application is needed.

For information on this product contact **Andrew's Audio, 401 Pacific Hwy, Artarmon NSW 2064. (02)438-4166.**

1984 - BIG BROTHER IS HERE!

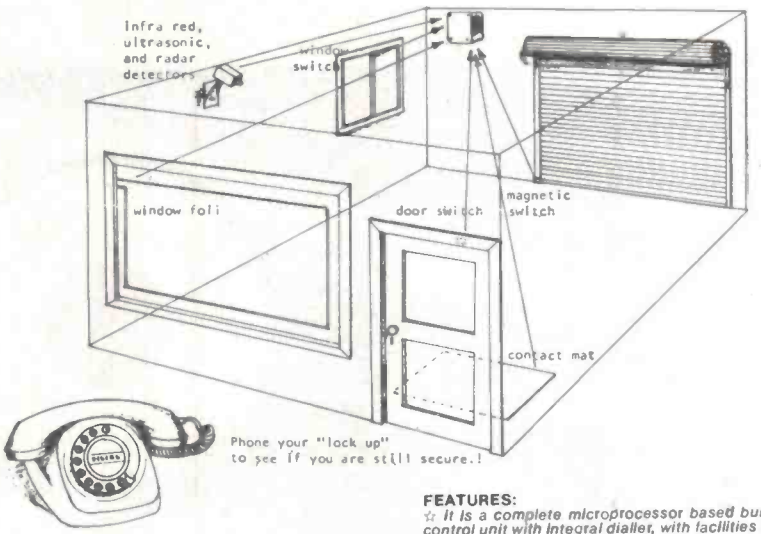
TELECOM APPROVED **NEW**

- A SOLID STATE TELEPHONE DIALLER/ALARM AT LAST!

This is one of the most significant products that we have seen for many years. It is a true "1984" product!!
What we are talking about is basically an alarm device that will telephone you (and two others as well) locally, SDT even ISD if your premises are broken into, is burning or even if the freezer has broken down! It does not use a tape recorder it is microprocessor generated and controlled. It is a 3 zone device as well i.e. it will give you a **separate message** to indicate the nature of any one of up to 3 separate faults.

TWO MODELS ARE AVAILABLE
1) DIALLER ONLY
2) DIALLER WITH POWER SUPPLY
and complete composite control module with N.O. and N.C. inputs, delay etc. This unit has a tamper proof steel box with space for a backup battery. (Charger is included in price).
BOTH UNITS PLUG STRAIGHT INTO A TELEPHONE SOCKET!

Cat. LA-5120 - Full alarm/control unit **$399**
Cat. LA-5130 - 4 zone dialler only **$299**
Both units are supplied in a metal cabinet.



OPERATION OF DIALLER
O When ALARMED the following takes place:- O The unit "grabs" the Telecom line from all other extensions O The dialler listens for "Dial Tone", when it hears the dial tone it dials out O Will even dial out an STD number or even from a switchboard (0 access) O After dialling the unit listens for "Ringing Tone" when it stops it:- will give a "bleep" message (the number of bleeps indicating the zone or zones alarmed) - will repeat bleep message and close down O If no dial tone is detected, the unit will go "off line" again and then try again (like replacing the receiver and then picking it up again) O If the line is engaged or none answers after a short time period the dialler will close down and dial the next number that is programmed in (a maximum of 6 attempts) O The units have 4 input zones which can be connected for all operating from N.O. contacts (or +12V dropping to less than ½V) or for all operating from N.C. contacts (or ½V rising to +12V) O A No AC signal is available which can be looped into a NO zone to give indication of supply failure (provided that the standby battery is fitted) O A Normally Closed contact is fitted to the case, to dial out if the unit is tampered with O The units have a return channel so that you can dial the unit up from a remote location and it will send bleeps indicating the last message that was transmitted. O Will operate with the following sensors:- N/C contacts - window foil - window/door switches, N/O contacts - mats, heat detectors, of operated and the contacts from Ultra-Sonic, radar, IR detectors and from most sector control units. O Operates from 12V AC or 13.6V DC (for recharging 12V battery) (or mains LA-5120)

FEATURES:
☆ It is a complete microprocessor based burglar alarm control unit with integral dialler, with facilities for 3 alarm zones and 1 test zone. ☆ It has the following zone options:- i) Delay zone for entry/exit with 30 second delay before dialling out and bringing in the alarm relay, unless switched 'off with a key switch, before this. ii) Instant zone, after the arming delay will dial out immediately and bring the alarm relay in. iii) Silent zone, will dial out but not bring relay in - option 1 can be switched 'OFF' with the unit - option 2 or a 24 hour panic or armed hold-up button iv) Test zone will ring in and tell you alarm is working at weekends etc. ☆ Can be programmed or re-programmed for all standard security receivers ☆ Unit is reset every time system is switched 'OFF' ☆ Can be installed by handyman ☆ No flashing lights to alert intruder ☆ Will phone up to 3 - 12 digit telephone numbers, silent zone can ring a 4th number (i.e. armed hold-up alarm could go to the shop next door and not an empty home) ☆ Will even phone STD Nos interstate ☆ Can signal fridge failure, mains failure, or fire etc.

NEW!!

LARGE COLOUR LED DISPLAYS! - Jaycar is proud to announce a NEW range of 7 segment LED displays featuring LARGE digits and alternate colours!

NOTE THE LOW PRICES!!

Cat. No	DESCRIPTION	1-9	10+
ZD1870	0.4"(10mm) Com Anode Red	$1.00	0.95
ZD1875	0.6"(15mm) Comm Anode Red	$2.50	$2.25
ZD1880	0.6"(15mm) Comm Cath Green	$2.95	$2.50
ZD1885	0.6"(15mm) Comm Cath Yellow	$2.95	$2.50
ZD1890	12x15mm rect diff block Red	$1.50	$1.25

The light blocks are simply a rectangular block of diffused light. They can be seen over great distances and are generally used as status indicators.
All devices have connection data supplied.

VIDEO HEAD CLEANING SPRAY - A-F Spray whilst designed for cleaning metal surfaces and leaving no residue it is absolutely ideal for cleaning video heads. It comes with an extension tube to get to remote spots. Leaves absolutely no residue and blasts away grime with no danger of scratching. A sound investment in VCR care. Also great for audio heads of course.

Cat. NA-1007 400 gram can **$8.95**

NEW!!

DESK TOP MAGNIFIER

Superb magnifying glass 90mm diameter mounted in a chrome ring supported on a 240mm flexible gooseneck. A sturdy cast base supports the unit.
Ideal for checking solder joints, PCB cracks, component identification etc. High magnification over large area will pick up tiniest flaws! A must in every serious workshop.
Cat. QM-3500

$29.95

NEW!!

UHF TUNER MODULE

This factory made unit enables you to cover the entire Australian UHF Band. The fundamental output frequency is actually around 35MHz, not VHF channel 1 as previously stated. A strong 'image' at VHF channel 1 appears, however. This enables the unit to connect straight to the antenna input of many VHF sets to enable UHF reception. The knob and reduction coil mechanism gives direct UHF channel readout!!
USES: - Can convert VHF (only) TV's to VHF/UHF
- Enables you to watch UHF output VCR's on VHF TV!
- Ditto for home computers & video games
Supplied with connection instructions and power supply info.

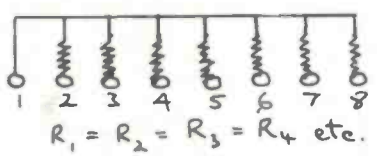
DON'T PAY HUNDREDS OF DOLLARS TO UPGRADE YOUR PERFECTLY GOOD VHF TV TO AN EXPENSIVE UHF SET!!

Cat. DM-9000 UHF Tuner Module..... **$34.50**
Cat. DM-9002 Knob and Dial to suit..... **$5.45**

PCB CLEANING SOLVENT

It may not be obvious, but many circuit problems occur when flux and other residues (even finger prints) remain on the PCB causing 'leakage' between tracks. If you work RF, high input impedance (i.e. FET OP amps etc), Ioniser or other circuits PCB cleanliness is a MUST.
The Jaycar PCB Cleaning Solvent is a spray that dissolves all flux residue and grime leaving the track work and board absolutely clean. We then recommend that you "tropicalise" the underside with spray-on lacquer. (Also available Cat. NA-1002 350 gram can $8.95).

Cat. NA-1008 454 gram can **$8.95**



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NEW!!

RESISTOR NETWORKS

STAGGERING LOW PRICES

Jaycar has secured a massive scoop purchase of quality resistor networks at unbelievable prices!!
The networks are wired as per schematic illustration, and all values in each device are the same. As very few hobby circuits feature networks at the moment, we feel that this product will only appeal to the service and OEM industry. If you are a user of resistor networks, send us a note and we will send you a specific list of stock with prices.
(We have probably the largest stocks and range in Australia). In the meantime we offer a "service pack" of networks at a bargain basement price. Each pack contains 50 assorted networks (Single-in-line packaged) in resistor values ranging from 680R to 1 Meg. (At least two of each network).

COST OF THE PACK?
ONLY $10!!

Cat. RR-3380

VCR SOUND PROCESSOR KIT

(Ref: EA April 1984)

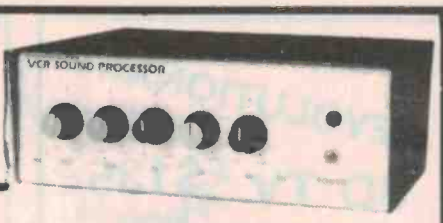
Great new kit for Video Enthusiasts! ● Stereo Simulator ● 5 Band Graphic Equalisation ● Noise Filtering

The Jaycar kit once again is truly original - down to the genuine multicoloured knobs on the front panel (watch for substitutes). The only extra that you will need to buy is the optional whistle filter (Cat. EE-3814 $19.95)

Cat. KA-1545

$55

NEW!!



NOT NEW!! - EA DIGITAL CAPACITANCE METER

(Ref: EA September 1980) Ideal for a bench type mains powered application. Measures from 1pF to 99.99uF in only 3 ranges! Large easy to read LED display.

Cat. KA-1105

$59.90

MUSICOLOR IV

Sound to light effect with 4 channel chaser. There are 4 different chaser patterns plus a host of other features. Complete kit

Cat. KA-1010 _____ **$89.90**

DUAL TRACKING #22V POWER SUPPLY

- Dual polarity can provide up to ±22V at up to 2 amps. Also has fixed output of +5V at 0.9A. Complete kit

Cat. KA-1410 _____ **$89.50**

(Ref: EA March 1982)

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12/230V - 300W INVERTER

300VA of power at 235V from an ordinary 12V car battery. Superb Jaycar kit is complete

Cat. KA-1114 _____ **$195.00**

(Ref: EA June 1982)

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COMPLETE KIT

- High efficiency emitter head - Fits completely inside a high quality ABS box (NOT a metal lid) - Only 2-core mains flex protrudes from the box - You can pay over $80 for a built-up inferior unit!

Cat. KJ-6511

NORMALLY $45

THIS MONTH ONLY

$29

SAVE $16

SHORTFORM KIT

- runs directly from 240V mains
- low power consumption
- produces high intensity electric field
- output around 7.5kV
- will not necessarily produce ozone in standard form
- ideal for those who wish to 'try' an ioniser at an economical price.

Cat. KJ-6510

NORMALLY $24.50

$15.00

SAVE UP TO $105 UNBELIEVABLE 'PHILIPS' SPEAKER BARGAIN

We have made a massive scoop purchase of genuine quality **Philips** European made Hi Fi speakers. They are so good they are used in the fabulous ETI 4000 series Hi Fi. If you thought the 4000/1 or 4000/2 systems were out of reach of your pocket - THINK AGAIN!

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NORMALLY $99.50 SAVE $30.00
THIS MONTH $69.50
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$201.90 value for $157.90 SAVE $44

EVEN CHEAPER for a stereo set i.e. 2 each of the above $315.80

SPECIAL 8 PIECE SET PRICE $299!!

Normal price for 8 speaker set $399!!

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2 x 3 (ETI4000/2) $129.50 Cat. CX-2627

ETI644A

! See ETI Jan '83!!

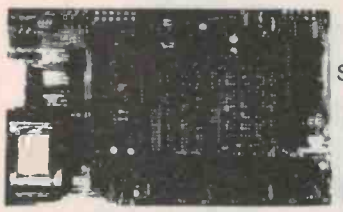
DIRECT CONNECT MODEM

Ref: ETI October 1982

Two models (i) Short form which contains ALL PCB components as specified by **ETI** (BEWARE!!). The genuine **ETI** PCB with plated-thru holes, solder mask and component overlay is supplied. We also supply at NO EXTRA CHARGE a full set of quality IC sockets. A must with plated-thru PCB - remember this when making comparisons.

(ii) Full kit. Includes : all of the above plus 12V plug-pack, case, switch and LED bezel and Cannon DB-25 RS-232 connector. Makes a complete stand-alone modem. ● Capable of a range of Answer/Originate operating modes ● Selectable Baud rate ● Software controlled ● Uses new patented technique ● More reliable and faster than most acoustic modems.

Arlec transformer as used in this project only $22.00



NEW MODEL

SHORTFORM KIT

Cat. KE-4600

ONLY $169

COMPLETE KIT

Cat. KE-4601

ONLY $199

Jaycar

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ELECTRONIC AGENCIES

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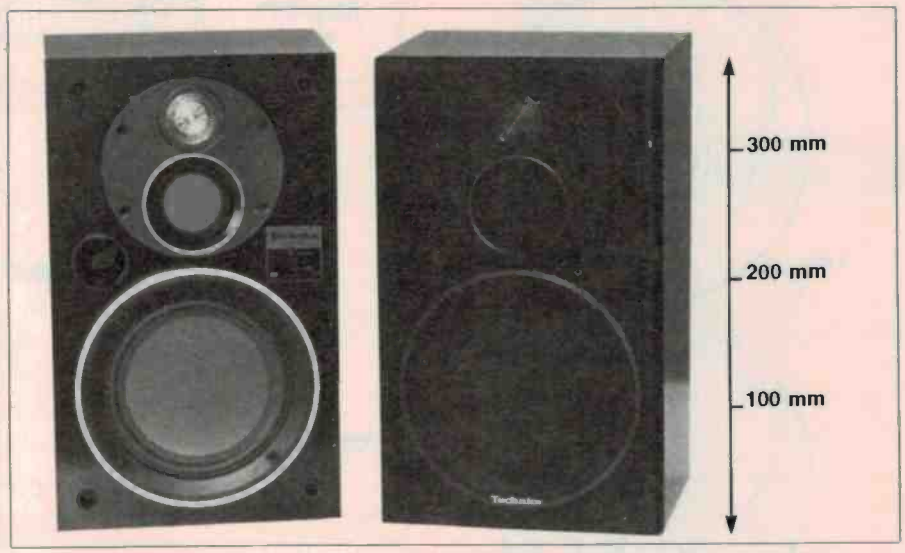
Technics SB-X100 loudspeakers

Louis Challis

TECHNICS HAS DEVELOPED a large number of innovative and attractive loudspeaker systems over the last four years. I have tested and used a number of the best of their products and I consider them one of the foremost loudspeaker manufacturers in the world.

Technics' most impressive recent developments have been associated with its honeycomb disc speaker systems which are just as exciting as their leaf-tweeters; both systems have an outstanding performance. Unlike the SB-10 system which I reviewed in ETI, July '81, the SB-X100 system uses three honeycomb disc drivers in a 'three-way' configuration. The designers have not used Technics' outstanding leaf-tweeter to cover the top end of the audible range as both the cost and size would be inappropriate in such a low priced system.

Initially I had asked to review the Technics SB-F5 speaker system which was released recently in America but has not yet arrived in Australia. It is fortuitous that my request could not be granted because the SB-X100 speakers have a performance which is undoubtedly superior to the system I had originally wanted to test and yet I believe they will most probably cost no more to purchase.



The flat frequency response, inaudible distortion above 120 Hz and impressive decay response spectra are as good as many speakers costing three or four times the price of this bookshelf system. Apart from some low frequency limitations, the performance of these speakers is excellent.

Features

The SB-X100 system is a true bookshelf system. It is well finished in an almost-black, plastic veneer which covers a heavy-density particleboard cabinet. The two speaker enclosures fit neatly into one small cardboard package which is about the size of the average single loudspeaker system that many advertising people classify as a 'bookshelf speaker' system. The front of each speaker is neatly covered with a finely woven black cloth that has been mounted over a plastic frame which clips into four neatly designed inserts located on the front face of the cabinet.

With the cover removed one's attention is immediately drawn to the purposeful and neat appearance of the three honeycomb disc drivers which are mounted in two groups. The 180 mm diameter honeycomb disc driver (or woofer) features a light, but reasonably rigid, honeycomb structure. This appears to be less expensive than that used on the SB-10 series speakers and has a smooth foam, plastic roll surround.

The woofer is located at the bottom of the cabinet with the mid-range and tweeter incorporated in a separate circular diecast secondary baffle located at the top. The mid-range speaker uses a similar honeycomb disc element, but it is far more rigid and appears to be particularly rugged.

The construction of the 28 mm diameter tweeter is the most impressive of the three drivers; the protection grid element appears to be based on the design of the protection grid used by Bruel & Kjaer in the front protection grids for their 25 mm diameter laboratory microphones.

The choice of this design configuration was probably intentional as Bruel & Kjaer did a considerable amount of research when developing their protection grids. I have visited the Bruel & Kjaer factory and having seen the wide range of experimental prototypes, I know how well the final design performs. It achieves the best possible high frequency diffusion and strength which are both just as important in the microphone as they are in this particular application.

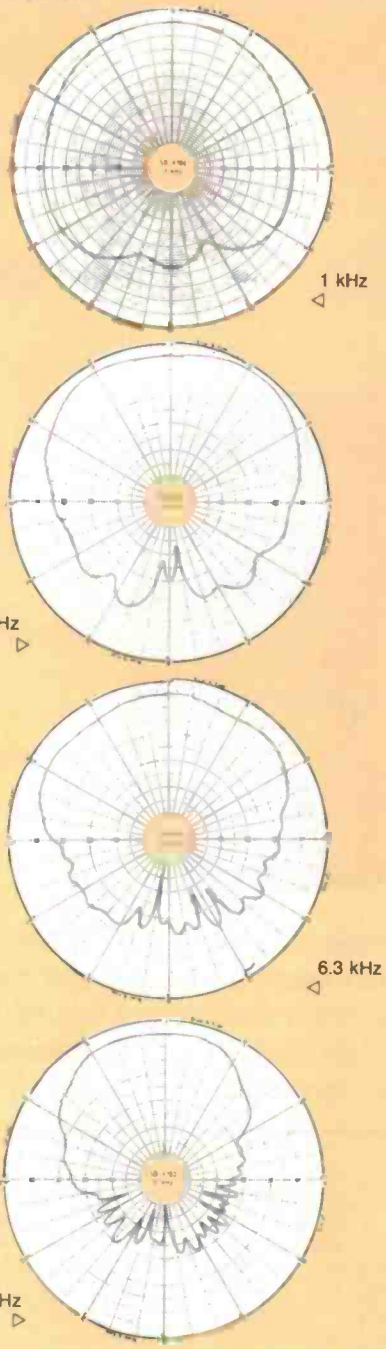
On one side of the cabinet is the 50 mm long, 30 mm diameter tapered port. This tapered configuration reduces the 'Q' to produce a smoother, low frequency performance. On the other side of the cabinet is a built-in thermal over-load relay which monitors the temperature rise on the loud speakers and switches off the input circuit in the event of abnormal operating conditions. The activation of this relay is indicated by a small, red light emitting diode whose illumination can be clearly seen through the very thin, black speaker cloth. This relay has to be reset by pressing a small reset button mounted beside the diode on the front panel.

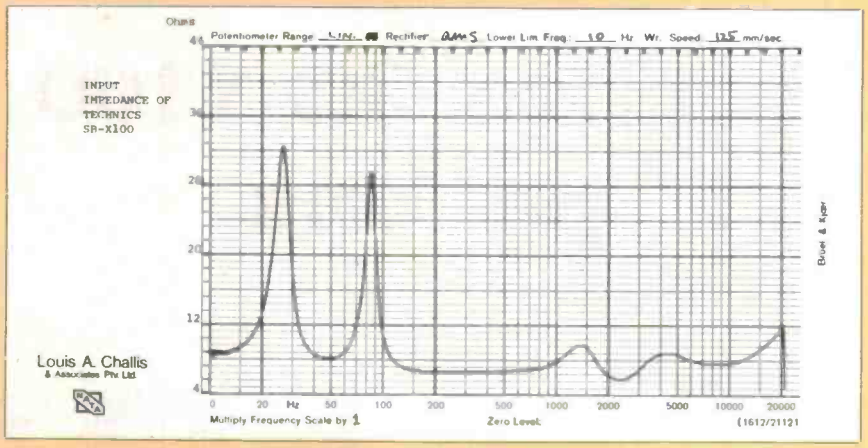
The rear of the cabinet features a pair of spring loaded terminals designed to hold bare speaker wires and these terminals are located in a solidly made, plastic recessed housing. The inside of the cabinet has been ▶

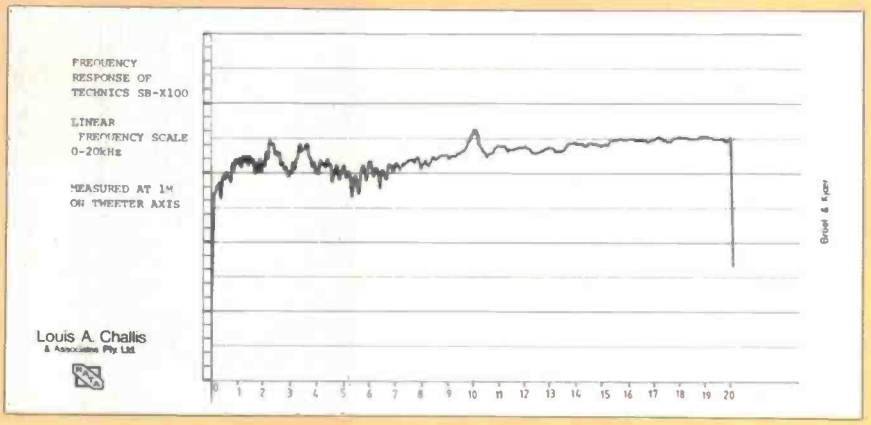
TECHNICS SB-X100 LOUDSPEAKERS

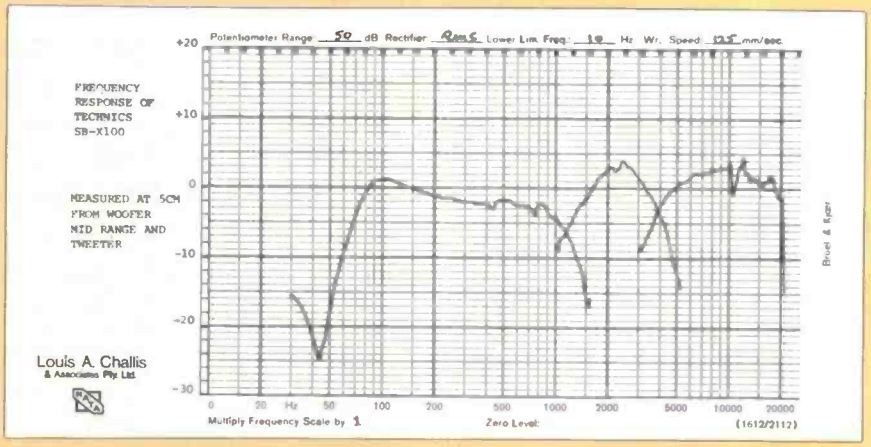
Dimensions:	*372 mm x 223 mm x 207 mm*
Weight:	*5.3 kg*
Price:	*Rrp $398 per pair*
Manufactured:	*In Japan by Matsushita Electric Industries.*
Distributor:	*National Panasonic (Aust.) Pty Ltd, 95 Epping Rd, Nth Ryde NSW 2113. (02) 887-5333.*

Polar response plots









effectively dampened with a reasonable thickness of felted underlay material while the sides and front of the cabinet have been solidly braced to reduced cabinet resonance effects.

Objective testing

The objective performance evaluation of the SB-X100 speakers produced results which were substantially superior to those one would normally expect from a speaker system selling at only $398 (recommended retail price).

The on-axis, as well as the off-axis, frequency response of the system is remarkably flat. The on-axis response extends effectively from 70 Hz to 33 kHz at −6 dB which is an extremely wide and smooth performance, considering the price of the system.

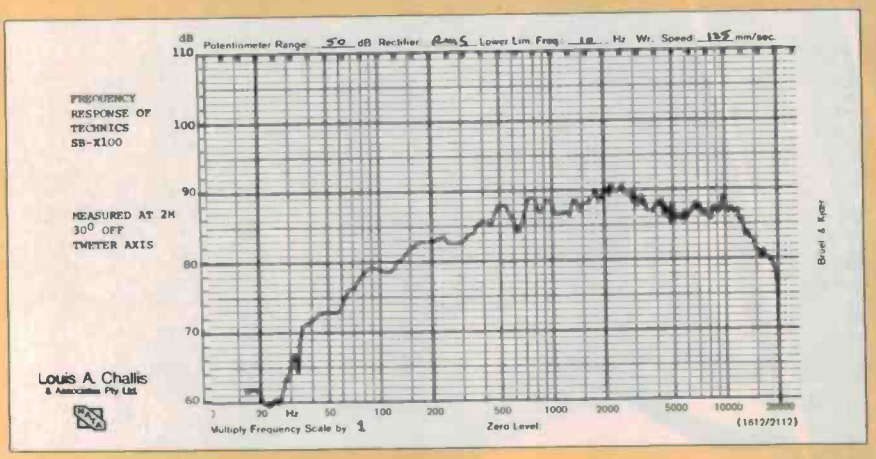
The off-axis response at 30° to the main axis extends from 70 Hz to 18 kHz, producing results which are generally as good as any speaker I have seen costing three or four times the price. The off-axis response is obviously controlled by the dispersion of the honeycomb disc tweeter which performs remarkably well to achieve such a smooth response within its working range.

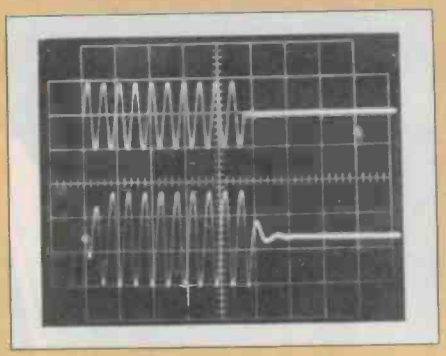
The measured response of each of the drivers has been exceedingly well matched and the linear plot of frequency response indicates to what degree the optimisation of frequency response has been successfully achieved.

The measured distortion of the system is quite acceptable, except at frequencies of 100 Hz and below where a 96 dB output signal at 1 m produces second harmonic, frequency doubling components which are audible. This degree of audibility increases with further lowering of the drive frequencies.

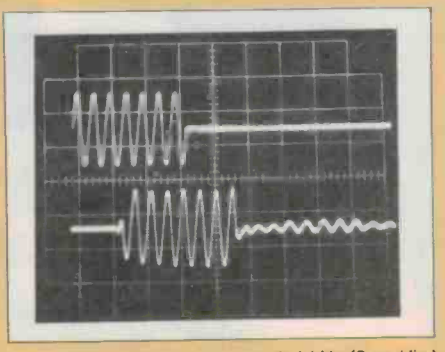
At frequencies above 120 Hz the distortion components are virtually inaudible and the measured results would make many designers of more expensive speakers quite envious.

The measured impedance characteristics of the SB-X100 illustrate the typical



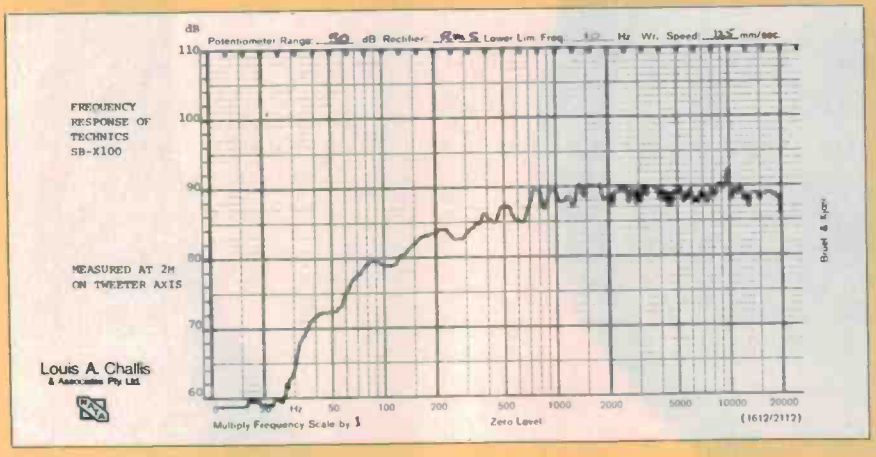


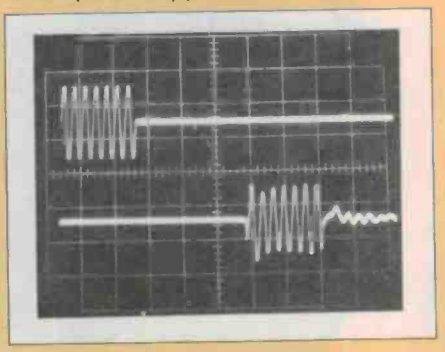
100 Hz (20 ms/div.)△



△ 1 kHz (2 ms/div.)

6.3 kHz (0.5 ms/div.) ▽





Tone burst response of the SB-X100 loudspeakers. For 90 dB steady state s.p.l. at 2 m on axis. Upper trace is electrical input, lower trace speaker output.

increases that one would expect at 27 Hz due to the speaker resonance, and at 85 Hz due to the loading port. The general impedance characteristics are quite smooth with a typical impedance of about six ohms. This speaker system could be paralleled with other eight ohm speakers, however, there would be some risk of excessive amplifier current except where the amplifier is capable of handling impedances of less than four ohms.

The phase response of the system is remarkably smooth providing a maximally smooth response all the way from 100 Hz to 20 kHz. In much the same way, even the tone burst response of this speaker system is excellent and there is not trace of abnormality at the standard test frequencies.

The cumulative decay response displays a performance with very few resonances; the only really significant resonances are at 10 kHz, which is in the audible range, and at 22 kHz which is not audible. There are two lesser resonances at 2.5 kHz and 3.5 kHz which are measurable, but not nearly as significant as the resonance at 10 kHz.

The porting resonance which shows up at 85 Hz in the decay response spectra is a result of the interaction of the port with the repeated impulse signal used in the measurement procedure. This is not a problem except in terms of the low frequency capabilities of the system.

The overall impression gained from the decay response spectra is that the designers have achieved a truly outstanding result from a particularly inexpensive speaker system. The results are as good as those provided by many speakers costing three or four times the price.

The polar plots produced in our anechoic room again illustrate the excellent lateral dispersion of the speaker at high frequencies. The sound dispersion at 10 kHz, in particular, is extremely good providing results comparable with other loud speakers costing many times the price. With a set of measured results as good as these, one would reasonably expect that the subjective results would also be excellent. ▶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Subjective testing

The subjective testing revealed that the SB-X100 produces a delightful and often superlative performance on most programme content, particularly where the dominant frequencies are above 100 Hz. The SB-X100 system is ideal for listening to classical music, low level monitoring applications (where the output signals are less than 96 dB at 1 m) and razor-sharp stereo imaging in either residential or even semi-commercial applications.

I listened to a wide range of operatic singing including Verdi's 'La Traviata' (Decca 400 057-2), featuring Sutherland and Pavarotti, which revealed the outstanding characteristics of both the singers and the speakers and produced a soft and smooth performance. As I consider that the clear production of speech is one of the most important attributes of a loud speaker system, it is obvious that the SB-X100s achieve an excellent performance in this category. The performance on transients was well illustrated by a new CD disc with George Frederick Handel's 'Music for the Royal Fireworks' (Oiseau Lyre 400 059-2).

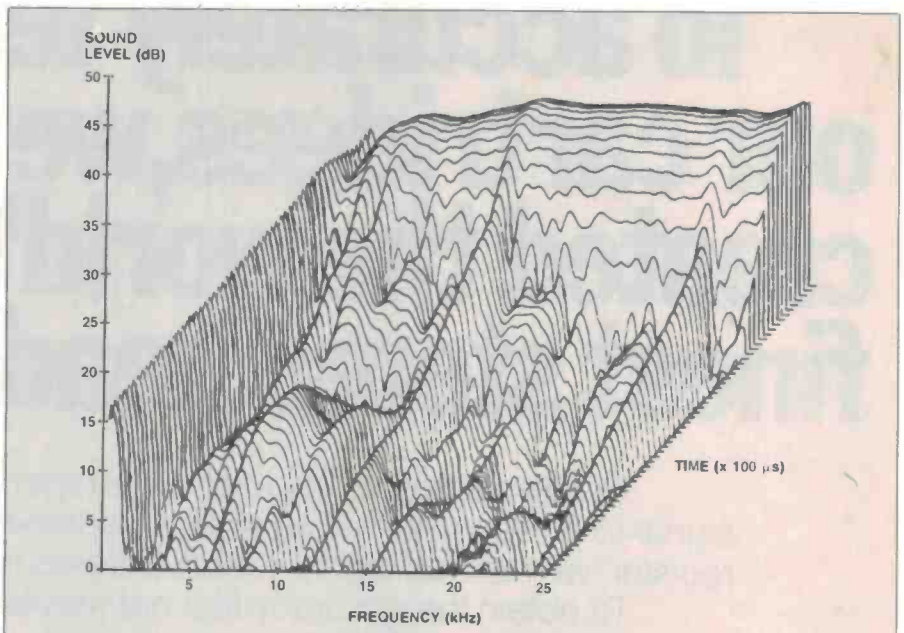
In a direct comparison with my B & W 801 monitors, the SB-X100s gave an excellent performance as long as the frequency content did not produce significant components below 110 Hz. When that occurred, the small dimensions and limited volumetric capacity of the SB-X100s were incapable of producing more than a poor replication of the original sound. This, however, is not a condemnation of the speakers, but rather an acknowledgement of the design constraints imposed by the particularly modest volume of only 17 litres.

When subjected to overloads from excessive power such as 250 watt transients provided by a Yamaha M300 amplifier, or even nasty transients provided by the signal content in normal music or tone arms being dropped on records, the protection circuit appears to function extremely well and I was unable to destroy these systems (although I tried).

Conclusion

The Technics SB-X100 loud speaker system was not designed to be a studio monitor system, the manufacturers have not claimed that it is suitable for rock music, and it has inadequate output power to be suitable for public address applications. Notwithstanding these obvious limitations it has many attributes, the majority of which are quite outstanding.

Provided you accept its low frequency limitations with an objective view point, this speaker system will most probably amaze you with its clean uncoloured fidelity and remarkable linearity. At a recommended retail price of only $398 per pair I believe the SB-X100s constitute an extremely good value for money, particularly where larger speakers would appear to be inappropriate. ●



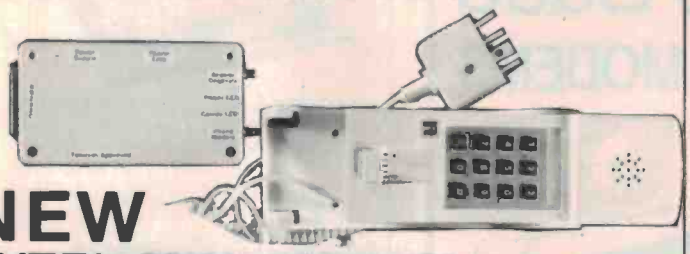
Decay response spectra. "A truly outstanding result". The only significant in-band resonance is at 10 kHz.

LOUDSPEAKER DATA SHEET

Measured Performance of Technics SB-X100
Serial No. TL 3215A337

Frequency Response (-12dB):	On-axis	70Hz - 33kHz			
	Off-axis	70Hz - 18kHz			
Crossover Frequencies :		1.5kHz and 4.0kHz			
Sensitivity (for 90dB average at 2m)		5.6 VRMS = 5.2 Watts (Nominal into 6 ohms)			
Harmonic Distortion (for 96dB at 1m)		100Hz	1kHz	6.3kHz	
	2nd	-22.8	-45.3	-40.6	dB
	3rd	-38.4	-42.3	-47.7	dB
	4th	-30.5	-69.9	-52.1	dB
	5th	-47.7	-58.1		dB
	THD	7.9	0.95	1.0	%
Input Impedance					
		100Hz	10.4		ohms
		1kHz	8.0		ohms
		6.3kHz	8.0		ohms
	Minimum at and typical minimum	2.4kHz	6.0		ohms
Phase Response	Maximally Flat				

1984 - BIG BROTHER MIGHT BE LISTENING... BUT WOULD YOU LIKE TO TALK BACK!



NEW AVTEK MINI MODEM

Possibly Australia's smallest Telecom approved (pending) MODEM
The **MINI MODEM** comes complete with a phone so that all you have to do is remove your standard phone and plug-in the **MINI MODEM.**
It is so small that you can mount the **MINI MODEM** on the skirting board next to the phone socket and use the Modem phone all the time as your standard phone.
SPECIFICATIONS: ★ 300 Baud CCITT V.21 answer or originate full duplex ★ Power indicator LED ★ Carrier detect LED ★ Answer/originate switch ★ Modem/phone switch ★ Plug pack power supply ★ Size approximately 65x130x40mm overall - SIMPLE AND SMALL!!

AVAILABLE SOON ONLY **$189.00**

The AVTEK MULTI MODEM is a completely Australian Designed and Manufactured Multi Standard Modem. It has been designed to meet current Telecom specifications (approval pending) and will be available in 4 different styles.

KIT FORM

This is for the hobbyist and is not approved for connection to Telecom lines. It is ideal for private line use and for the Amateur Radio operator for Packet Radio (See review EA January 1984). Complete kit to the last nut and bolt including pre-punched and silk-screened front and back panels.

ONLY $249.00

MODEL MM2

This is a completely assembled and tested unit with a telephone hard wired into the Modem. It can be plugged legally into any phone socket to replace your standard phone.

INTRODUCTORY PRICE $329.00

MODEL MM3

This is basically the same model as MM2 but does not include the telephone but comes fitted with a data Telecom plug which means a dedicated socket must be installed by Telecom.

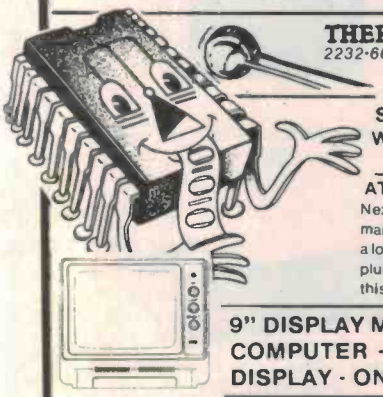
CONTACT AVTEK FOR PRICE

MODEL MM4

This unit is basically the same as model MM3 but does not have externally selectable Baud rate. The mode of operation is factory set. This is ideal for dedicated dial-up lines. This model also has hardware Auto Answer included.

CONTACT AVTEK FOR PRICE

SPECIFICATIONS FOR KIT, MM2, MM3 and MM4: □ **Data Standards** CCITT V.21 & V.23, Bell 103 & 202 □ **Data Rates** 300, 600 and 1200BPS □ **Backward Channel** 75BPS in conjunction with 1200BPS □ **Computer Interface** CCITT V.24 (RS232C) □ **Power Requirements** 240V AC 3 watts □ **Front Panel Controls** Mode Switch (12 position rotary - not MM4). Connect Switch (3 position toggle). Test Switch (3 position toggle) □ **Front Panel Indicators** Connect LED, DCD Data Carrier Detect, RXD Received Data, RTS Request to Send, CTS Clear to Send, TXD Transmit Data, RING Ring Detect, TEST Test Switch off normal, POWER.
NOTE: Models MM2, MM3, and MM4 will not be available until Telecom approval has been obtained.



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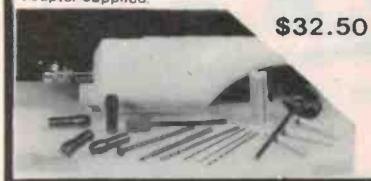

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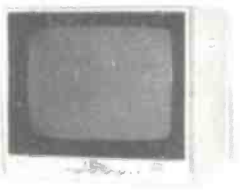

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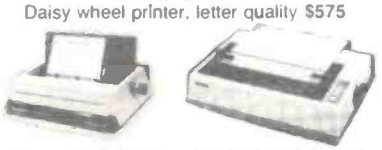

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IBM's million bit memory chip

An experimental computer memory chip that can store more than one million bits of information has been fabricated on an existing manufacturing line at IBM's facility in Essex Junction, Vermont.

The experimental chip, called a one-megabit dynamic random access memory (DRAM), was fabricated on the same manufacturing line the company has used since 1978 for mass production of 64K and 72K high-density memory chips.

Use of these existing manufacturing facilities has both demonstrated the chip's manufacturability and accelerated its development for potential use in IBM products.

A number of improvements in photolithography and processing technology contributed to the development of the one-megabit chip. For example, enhancements to conventional optical lithography and photoresist formulation made it possible to fabricate circuit elements on the chip as narrow as one micrometer — about 1/50 the width of a human hair.

The high storage density (13 025 bits per square millimeter) of the new chip is also derived in part from the use of advanced processing technology. A new processing step that electrically insulates adjacent storage nodes from one another allows them to be placed less than 1μm apart without creating unwanted electrical effects that would tend to impair chip performance.

Another processing development that directly contributes to the density of the one-megabit chip is the use of an extremely thin layer of a composite dielectric material to cover the storage nodes. This layer is only 15 nanometers thick, or about 50-60 atoms high.

Reducing the thickness of this layer makes it possible to increase the amount of electrical charge that can be stored without increasing the area of the node, which takes up a sizeable fraction of the memory cell itself. In this way, a strong and easily sensed signal can be obtained from the cell without the need to enlarge its area.

The process is already sufficiently developed to produce perfect chips. Individual chips have been made in which it is possible to access each of the 1 048 576 memory cells.

The chip is packaged on a 22-pin ceramic substrate with a packaging density of four megabits per square inch.

It operates with a single-voltage, 5 V power supply. The one-million-plus memory cells and their support circuitry occupy an 80.85 square millimeter area of silicon. The chip dimensions are 10.5 mm by 7.7 mm. The time needed to read data out of the chip is 150 ns.

Karen Kaigle holds a silicon wafer. The wafer contains memory chips that can store more than one million bits of data. The wafer will eventually be diced into almost 100 individual chips.

Xidex disks

Magmedia, Australia's largest supplier of floppy disks, has begun manufacturing Xidex Precision disks at new premises in Gladesville, NSW.

Last November Magmedia became sole Australian distributor for Xidex disks which are produced by Xidex Corporation of California, and distributed worldwide.

The 5¼" and 8" precision disks are the first to be designed to the exacting standards required of 96 TPI high density recording, the company claims. They claim the highest certification level in the industry and incorporate a new magnetic particle which provides a strength 20 per cent above the accepted industry average, they say.

Recently the company released a 555 foot length DEI data cartridge, the first extended length ¼" digital tape cartridge which is fully compatible with the ANSI industry standard 300 and 450 cartridges, and a new computer tape called the Epoch 480 manufactured by Graham Magnetics of the US.

For further information contact **Magmedia, 28 Buffalo Rd, Gladesville NSW 2111. (02)816-3222.**

Pulsar boost

If you built the Little Big Board project (ETI-690, Oct '83), you may be interested to learn that Pulsar Electronics, designers of the Little Big Board, have just been named one of three preferred suppliers of computer equipment to Victorian State schools.

The Victorian Education Department Computer Centre named three micros for use in its schools during the next few years. They are the Commodore 64C, the Apple II and the Pulsar 6000. The choice of computer is not binding on all the state schools, but the centre will only provide instruction and software for these three.

Competition for preferred supplier status was fierce, with over three hundred suppliers registering their interest. Machines were evaluated in three categories, low for primary schools, medium for years 7 to 10, and upper for senior high school. One of the favoured middle range machines was the BBC micro, which Barson Computers had planned to manufacture locally, but apparently it failed the 7B test.

The 7B test, according to Mr Nick Wilkinson of the Computer Centre, involves leaving the computer with class 7B students for an afternoon.

According to Mr Wilkinson the "bare copper male connectors" of the BBC micro wilted under the strain.

For more information contact **Pulsar Electronics, 2 Melrose Drive, Tullamarine Vic. 3043. (03)330-2555.**

Networking for TRS-80

Arcnet, a local-area network based on Datapoint's 'Attached Resource Computer Network', is now available in Australia through Tandy Electronics.

Tandy will utilise Arcnet protocols and software, plus a new LSI integrated circuit network interface component, to allow multiple TRS-80 Model II or Model 12 computers to be linked into effectively large-scale systems to create a low-cost local networking system for up to 255 computers.

Arcnet is compatible with most Model II software.

For further details, contact **Tandy Electronics, 91 Kurrajong Avenue, Mount Druitt NSW 2770. (02)675-1222.**

New 8-bit micro

Zax Corporation has introduced 'The Box'. The Box is a powerful CP/M based Z80A 8-bit microcomputer with built-in EPROM programmer, two 8" double-density, double-sided floppy disk drives, 64K of RAM, four RS232C serial ports (75 baud to 19 200 baud), AM9511 socket and interface circuitry for high speed arithmetics and one parallel Centronics plug compatible port.

In addition, one 8" drive and on 5¼" drive may be added as an option. The disk drives are designed to take into account inter-changeability between diskette formats. The formats of standard diskettes are switched automatically by insterting a diskette in Drive A, then the diskette on any of the other drives will be treated as the same format.

If mixed use of diskettes of different formats is desired, XDSKMOD software is available for diskettes that are not standard. XDSKMOD allows the uses to select different formats including number of blocks, block-size, sector size, directory size, track number, sector skew, and so on.

The Box has a System Expansion Module equipped with four channels of RS232C serial interface, 48K x 4 expansion memory and 40M Bytes hard disk interface controller.

Other options include a RAM expansion module that adds 768K (48K x 16) of memory to The Box. This module is a single board that plugs into any slot and can be used as a virtual floppy disk or Data Acquisition System.

Also included in The Box mainframe is an EPROM programmer. This device can program any EPROM up to 28 pins with a 5 V Vcc and Vpp of +25 V or +21 V. To switch between PROM types simply plug in the supplied Select Module.

For further information please contact **Z Systems Pty Ltd, 196B Vulture Street, South Brisbane 4101. (07)44-3715.**

Cheaper VIC-20 software

Ozi Soft has announced a price drop of its entire range of VIC-20 software down to as low as $9.95. This includes games such as Macpan, Cops and Robbers, Kongo Kong and Skramble, and programs in the education and small business application areas.

There have been a number of new releases for the Commodore 64 including new games from the UK and USA, while the three new business packages from Southern Solutions fill a gap in the Accounts Payable, Receivable and General Ledger Accounting areas.

A word processor and information management package has been released for the Commodore 64. Insta-Write, a word processor on cartridge, acts as the integrating package between Insta-Mail (a mailing list) and Insta File (a powerful data base).

The total package is available on cassette or disk and, as a special offer, the disk version comes with a complimentary Financial Spreadsheet.

For more information contact **Ozi Soft, 50 Clarence St, Sydney NSW 2000. (02)29-6330.**

Micro clearinghouse

The Royal Melbourne Institute of Technology has attracted 16 international and local computer companies and peripheral suppliers to its Australian Microcomputer Industry Clearinghouse, AMIC.

A concept new to Australia, the Clearinghouse offers microcomputer owners, operators, and potential users a range of services including access to hardware and software for personal evaluation, either in a self-learning mode, or with demonstrator assistance.

AMIC's general manager, Mr Don Schauder, predicts that the Clearinghouse's neutrality would appeal to individuals, and business firms, looking for somewhere to sort out their microcomputer options without sales pressures. "As we don't sell computers, people using AMIC can be assured of total impartiality," he said.

Mr Shauder says that the Clearinghouse is geared towards providing low-cost public access to computer time and associated training activities. "People can book time on any of our machines for $6 per hour. For students, the fee is $3. Where the assistance of one of our 30 demonstrators is required, the hourly rate is from $20."

Australian manufacturers, whose participation in AMIC is being sponsored by the Federal Department of Science and Technology, are represented by Case Communications, Datacraft, Digital Electronics, Hartley and SME.

AMIC occupies a suite of offices in Gateway Place, in Swanston Street, opposite the Royal Melbourne Institute of Technology and is open on weekdays and on Sundays. Courses are being conducted on most days, including 1½ hour breakfast sessions covering specific products.

The Australian Microcomputer Industry Clearinghouse is a joint venture involving RMIT, its subsidiary, Technisearch Limited, the computer industry, and the Federal Department of Science and Technology. For further information contact Peter Wilkinson, **(03)341-2943** or Don Schauder, **(03)348-1775** or write **AMIC, G.P.O. Box 2476V, Melbourne Vic. 3001.**

Atari cutbacks

The woes of Atari Inc, the embattled US video games producer, continue.

The company is laying off 550 people at its factories in California and Puerto Rico. This is the latest chapter in a saga that has seen Atari retrench much of its US work force as production moves into SE Asia.

The Atari 600 and 800 home computers and the 2600 and 5200 games machines will continue to be assembled exclusively in Asia.

The only good news for job hungry Americans is that Atari has promised to begin production of some yet-to-be-announced games products at El Paso, Texas. Spokesperson Bruce Entin said that workers who moved to El Paso (at their own expense) would receive "preferential consideration" in hiring.

Floppy copy

Magmedia has introduced Applied Data Communications' new high speed IC4800 floppy duplication system to support the overworked IC450 'Floppy Copy' system.

Kevin Biggs, Magmedia's Technical Director, states that the new equipment can duplicate and verify double-sided 40-track 5¼" floppy disks in 21 seconds.

Software masters may be imported at 2% duty rate if they are to be used for duplicating purposes. This will save importing large amounts of untried software at 35% duty.

Magmedia will also be offering software protection schemes with varying degrees of sophistication.

For information contact **Magmedia, P.O. Box 442, Gladesville NSW 2111. (02)816-3222.**

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C-Tech update

The rapidly growing computer industry is being specially catered to by Ritronics. Their C-Tech division, situated at 48 A'Beckett St, Melbourne, is specifically for selling and maintaining computers, peripherals and software.

Managing director, Greg Boot BSc., has announced the introduction of the Big Board Three single board computer to enhance their successful range of BB1 and BB2 computers. The prototype is on display and features a 6 MHz Z80B, on board modem, voice synthesiser and 256K of RAM. Future expansion to 8088 and full high resolution colour graphics is planned.

The popular home computers including Apple, Microbee, Spectrum and Commodore 64 are supported with comprehensive ranges of software.

The ability of computers to be updated instantly to new applications has meant that the software provided by C-Tech is very popular. Computer owners delving deeper into the technical aspects of computing will find many programs available that aid software development, such as advanced programming languages and assembler, editor systems.

The all too common problems encountered when implenting new features on CP/M computers have been solved in many cases with the technical service provided by Greg and his staff.

For more information contact **C-Tech Pty Ltd, 48 A'Beckett St, Melbourne Vic. 3000. (03)347-7917.**

CLUB CALL

The Sydney Microbee Users Group now has two meetings each month. The evening meeting is on the first Tuesday of each month at Auburn Girls High School, Braemar St, Auburn from 7 pm to 9 pm. The regular Saturday afternoon meeting is held on the third Saturday of each month at the McMahons Point Community Centre in Blues Point Rd, Nth Sydney (near Lavendar St) from 1 pm to 5 pm.

The Broken Hill Microbee Users Group meets on the last Sunday of each month. For information contact Peter Cotter, 553 Radium St, Broken Hill NSW 2880. (080)88-1621.

A **Spectravideo Users Group** has just been started in Victoria. For information about this club contact Mitch Raitt, Fernhill, Tindal's Rd, Warrandyte Victoria 3113. (03)844-3485.

The **BBC Users Group** of Tasmania holds monthly meetings on the first Monday of each month at the Elizabeth Matriculation College in D Block (entrance off Warwick St), Hobart, commencing at 8 pm.

Enquiries about membership etc. can be directed to John M. Hannon, P.O. Box 25, Nth Hobart Tas. 7000. (002)34-2704.

The **TI-99/4 Users Group** in Melbourne meets monthly at the Victoria College, Burwood. The group issues a newsletter bi-monthly, six program tapes per year and runs demonstrations, tutorials and a special interest group in Assembler language.

For further information contact Wayne Worladge, 123 Ashburn Grove, Ashburton Vic. 3147. (03)25-1832.

For information about the **Microbee Users Group of SA, Inc (MUGSA)**, write to the secretary, G.P.O. Box 767, Adelaide SA 5001.

The **Melbourne Atari Computer Enthusiasts** group (MACE) meets at the Rotunda at Monash University on the first Sunday of each month at 11.40 am. Visitors (non-members) are charged $1 to cover costs. Tea and coffee are provided along with demonstrations of the latest software and hardware.

Meetings cover games, applications and languages for the Atari 400, 800 and XL personal computers. For more information contact M.A.C.E., P.O. Box 133, Mulgrave North, Vic. 3170.

The **Newcastle Microcomputer Club** meets on the second and fourth Mondays of each month at 7.30pm in room G12, Physics building, Newcastle University. Our mailing address is P.O. Box 293, Hamilton NSW 2303, or ring Angus Bliss on (049)67-2433 ext. 326 bh. or Anthony Nicholson on (049)52-6017 ah.

Program recorder

For owners of personal computers one of the most difficult hardware decisions is selecting the correct mode of data storage. Disks are a very nice way to go, but the price puts them out of the range of many users. Using a conventional audio cassette recorder is cheap, but it's slow and unreliable.

Midway between the two alternatives sits the National RQ8100.

It has a data storage rate of 1200 bps, and a remote control jack that permits start/stop instructions from the computer. The recommended retail price is $89.95.

For more information contact **National Panasonic, 95 Epping Rd, Nth Ryde NSW 2113. (02)887-5333.**

Jap apple

The Japanese manufacturer, Sony, and Apple Inc of the US have formed a technology sharing agreement on hard disk computer memory technology. Although details were not disclosed, both companies said they would develop new hard disk drives from their joint technology operations.

There is already a degree of cooperation between the two companies. Sony supplies micro floppy drives for Apple, who use them in the Lisa 2 and MacIntosh.

Turbodos computer

A new Pulsar series 7000 turbodos computer system is the latest in a range of computer systems. The series 7000 is a one-to-four user system (with each user having their own Z80A and 64K of RAM.) Mass storage is handled by a combination of hard disk (to 100M), 5.25" 1.4M mini-floppy and 5M removable hard disk. Air flow is via positive pressure 4" fan. Power supplies are available to 15A. System boot-up is via the hard disk with a key operated reset/power on function.

Further information can be obtained by contacting **John Reardon, Pulsar Electronics, Lot 2, Melrose Drive, Tullamarine Vic. 3043. (03)330-2555.**

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* Osborne
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Sesame Street software

Tandy Electronics has begun marketing two new educational programs that were created by the Childrens Computer Workshop, part of the same outfit that produces Sesame Street for TV.

The software was written for a 32K TRS-80 colour computer with extended colour BASIC.

'Play with language' is designed for first and second year kids to complement early reading experience.

'Hands on' introduces children to the computer, teaching them familiarity with the keyboard and how to handle the colour functions on the TRS-80.

Price for both programs is $149.95.

Contact Tandy for details at **91 Kurrajong Ave, Mt Druitt, NSW 2770. (02)675-1222.**

New general manager at NEC

Mr David Ballantine has now taken over the position of General Manager, Planning and Marketing, at NEC Information Systems Australia Pty Ltd.

Mr Ballantine was previously Sales manager, Australia and New Zealand, for Digital Equipment Corporation. He worked for DEC for 11 years in the UK, US and Australia, and before that for Australian Iron & Steel.

In his new job Mr Ballantine is located at the NEC head office in St Leonards, NSW.

Commenting on his new position, Mr Ballantine states that he is delighted to be joining NEC, a company whose current performance and growth potential he sees as particularly outstanding.

Line tamers

Ferguson has produced a new range of line transformers specifically for the operator of micro computers.

The transformers ensure a constant 240 V from a mains supply that varies anywhere between 190 and 275 volts.

They claim their 'line tamers' will not pass spikes on the line, and at the same time will provide protection against lightning strikes.

Mini line tamers are available in 160, 275, 550 and 1000 Watt versions.

For more information contact **Ferguson Transformers, 331 High St, Chatswood NSW 2067. (02)407-0621.**

Brief case portable

Texas Instruments has a new portable printer, the TI 703, which is now available in Australia.

The TI 703 weighs 3 kg and fits into half a briefcase. It is clearly aimed at business people who, for one reason or the other, need to communicate with their office system.

Data communications is established via a Telecom approved accoustic coupler. Power supply is either mains or battery.

The unit is equipped with a QWERTY keyboard and a thermal printer which, the makers claim, is almost silent.

For more information contact **Texas Instruments, 6 Talevera Rd, North Ryde NSW 2113. (02)887-1122.**

Disk conversions

This to That is a Sydney based bureau service specialising in the conversion of Word Processing diskettes prepared by one manufacturer directly to the Word Processing diskette format of another manufacturer.

The aim of the service is to provide a maximum intelligence conversion where only minimal editing is required on the new Word Processing diskette. This is achieved by transferring the information on a direct disk-to-disk basis, thus enabling conversion of many of the input diskette control codes directly to the new code form required for the output diskette.

This automatic disk-disk transfer method particularly means that client information is never displayed on a screen for editing and is therefore totally secure at all times.

Transferred features vary according to the particular input Word Processing system but typically include: Bold, underline, format control grids for margin and tab stop settings, page breaks, superscripts and subscripts, indents and tabs.

For more information contact **This to That, MLC Building, 105 Miller St, North Sydney, NSW 2060. (02)923-2755.**

Basic Z

Software Source has just announced an all new version of the Basic Z compiler by System Z.

The new compiler replaces the single user product and promises total compatibility with numerous operating systems, such as CP/M and TURBODOS.

It is claimed to be the only compiler for micros that offers both operating system and hardware independence. Price is $495 per installation.

To find out more about Basic Z call **Software Source, 344 Oxford St, Bondi Junction NSW 2022. (02)389-6388.**

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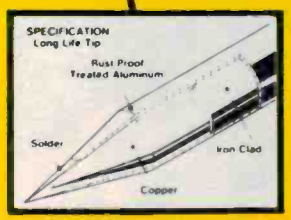

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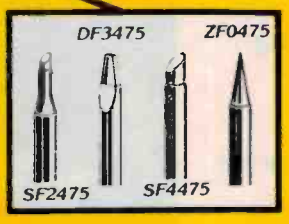

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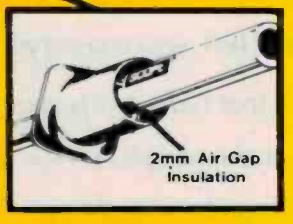

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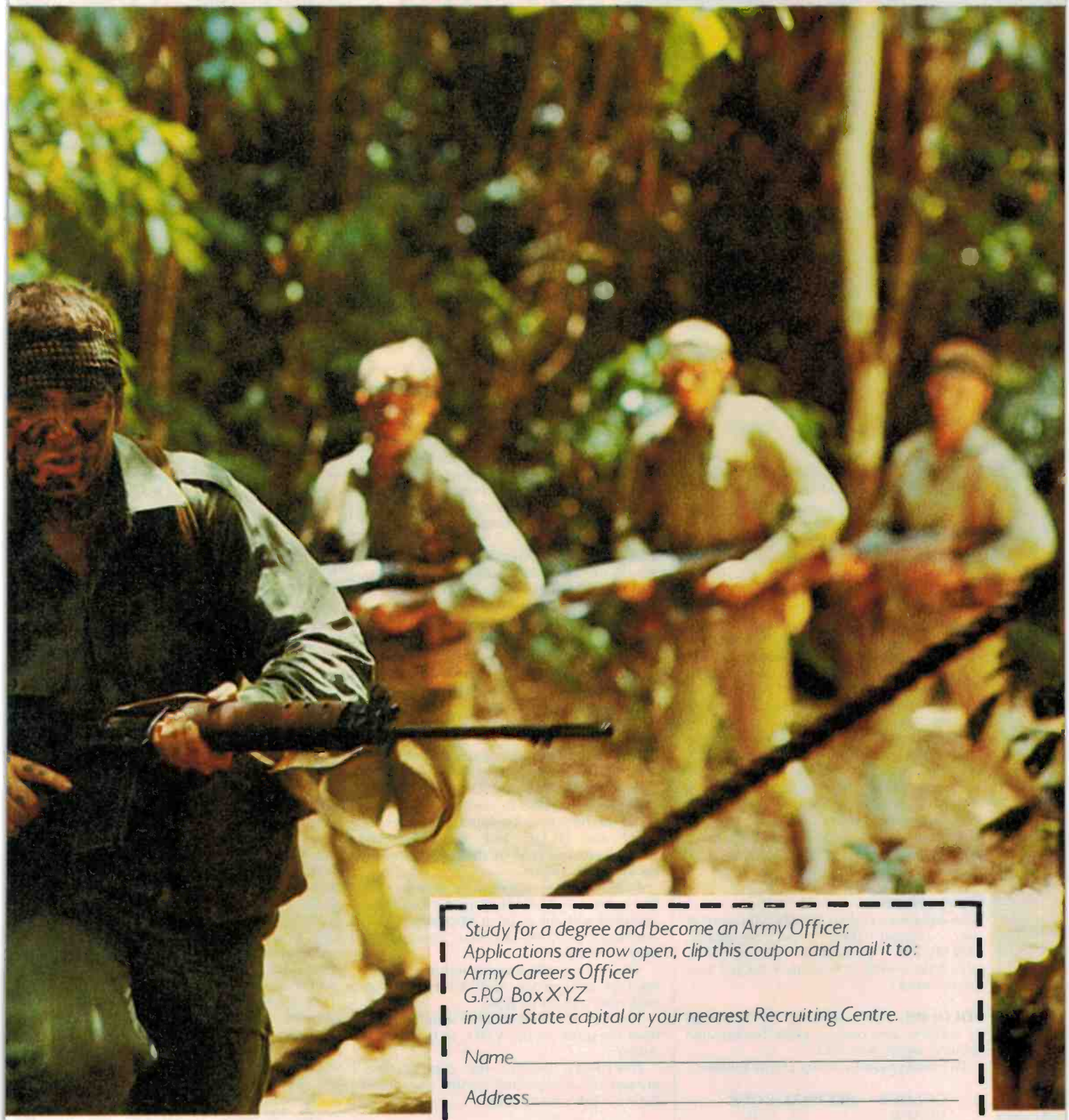

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enough?

An owner's view

Colour conversion of the Microbee

Thinking of upgrading your 'Bee to colour? Here, Mike Hennessy reviews what he went through with the colour conversion of his 'Bee and explains the software additions, their use, advantages and disadvantages.

Mike Hennessy

COLOUR CONVERSION of the Microbee gives you the new Colour BASIC, version 5.22e, Wordbee and terminal communications. The conversion will be performed by Applied Technology. Microbee owners may be asking themselves if the change is worth it. Well, this is one answer.

RGB Conversion

I will assume that the main interest is in the colour enhancement of the 'Bee; Wordbee and terminal communications deserve separate articles by themselves.

Physically, the conversion consists of fitting the new RGB colour module to the underside of the main board. The colour signals are brought out to a 15-pin socket, fixed to the new module and positioned beneath the serial port. A slot is cut into the case to accommodate the new socket. The connections between the main board and the RGB module are extensive, some changes are made to the main board, and in some cases the core board is also replaced. To sum up, Applied Technology insist on doing the work, this is not a case of simply plugging in extra ICs.

How long does it take Applied Technology to do the work? Well, with the unit under review it was handed in at their Gosford plant about 11.00 am on one day and picked up at 9.00 am at their showroom at Waitara on the next! That is what is called *service*.

Colourbee

With Microbee Colour BASIC you have at your disposal three new commands; COLOURB, COLOUR, COLOURM. Let's have a look at what they do and how they're used.

COLOURB. This command, "COLOURB n," selects any one of eight background colours, where n = 0 to 7.

The background colours are as follows:

COLOUR	DECIMAL CODE
BLACK	0
RED	1
GREEN	2
YELLOW	3
BLUE	4
MAGENTA	5
CYAN	6
WHITE	7

If you follow the command with a CLS the screen clears to the selected background colour. If CLS is not used and COLOURB is followed by a PRINT instruction, then the selected colour is used as background for that print. It is therefore possible to develop in your displays, combinations of the eight background colours on the screen.

COLOUR. The command "COLOUR N" selects the foreground colour used for any PRINT, PLOT or the SET instruction. However when used with PLOT or SET one disadvantage is that the colour information is set for the character block used, you cannot set alternative pixels in the same block to different colours. This was a distinct disadvantage when using the HIRES graphics.

Although 32 foreground colours are specified as "describeable", the first eight colours are the same as for the background colours, after that the colours are variations of combinations of background and foreground colours for a total of 255.

In addition, just to confuse you, when using the foreground colours, the codes for RED and BLUE and YELLOW and CYAN are reversed to that given for the background colours.

For those who argue about how to spell the word . . . COLOUR or COLOR are accepted without error in Microworld Colour Basic; COLOR, of course, uses one less byte of memory.

The other graphics commands that can be used in conjunction with COLOUR are underline and INVERSE.

The use of UNDERLINE simply underlines the print, to the VDU, in foreground colour.

INVERSE reverses the current foreground and background colours when used before a print instruction.

COLOURM. As an instruction, "COLOURM n", is designed to give you a half-amplitude colour signal with the colour being selected by using the same code as for the background colour.

COLOURM 4 immediately sets the background to a half-intensity BLUE. There is no need to implement CLS to obtain a background change, as you would do if using COLOURB.

As the normal RGB and half-amplitude RGB signals can be mixed, it is therefore possible to develop 64 background colours by combining COLOURB and COLOURM commands.

COLOUR and POKE

If you wish to use POKE instructions to change any of the colours, then this can be readily done by placing the required decimal code at these memory addresses:

POKE 156,n	foreground colour
POKE 157,n	background colour
POKE 158,n	half intensity background colour.

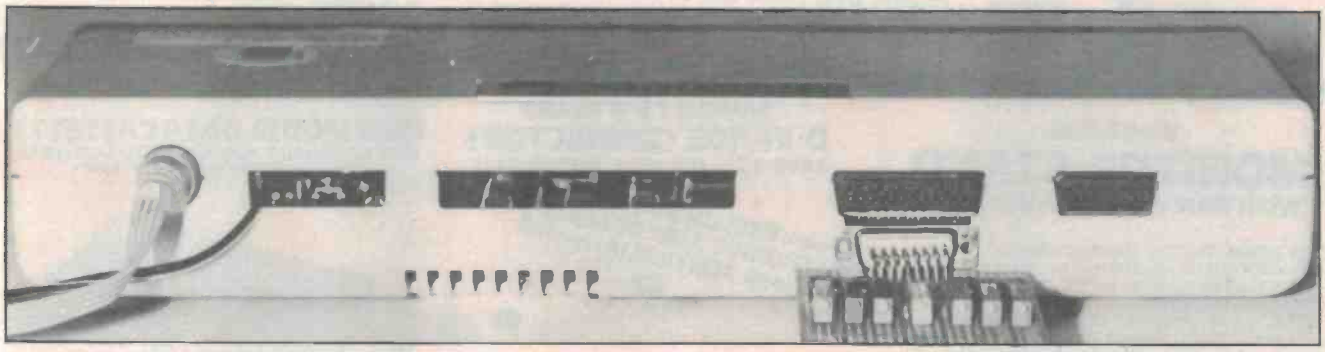
Hardware and the half mode signals

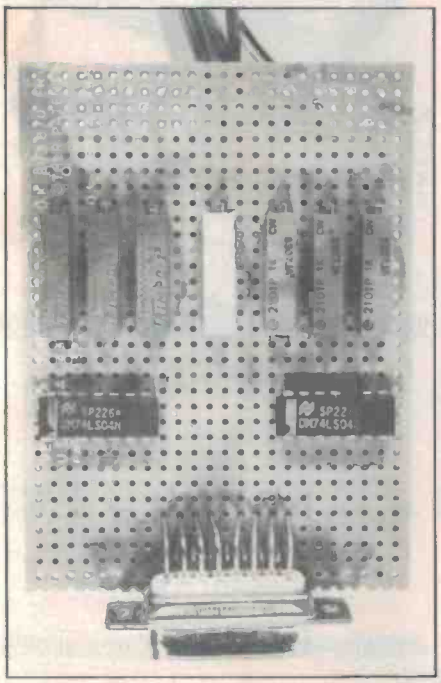
On the 15-pin socket from the RGB module you will find the RGB colour signals, the half-mode R/2, G/2, B/2 signals, positive and negative synchronizing pulses, ground and a surprise +5 volts on pin 9 of the socket. The latter has been added by Applied Technology, as a modification to the RGB module. In my case the pin connections supplied for the module had this signal as ground, it was found by accident and could have been disastrous for the 'Bee if connected to ground as the pin diagram would have you believe.

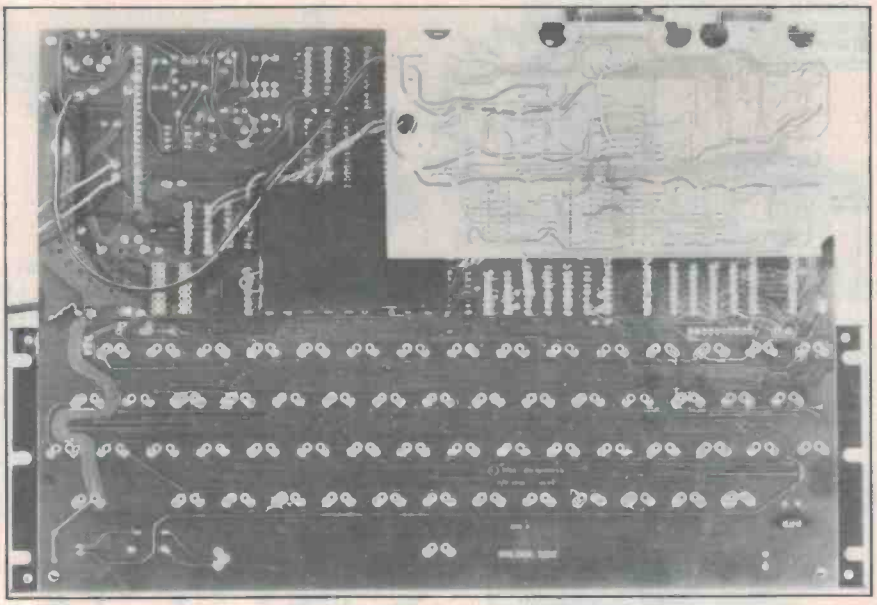
Fortunately, this +5 V is required for the RGB interface board that is not supplied with the conversion. The interface board does two things; firstly, a means of mixing the RGB and half intensity RGB signals, secondly, it is a buffer between the 'Bee and your TV set and provides you with a means to preset the levels of the signals to the set.

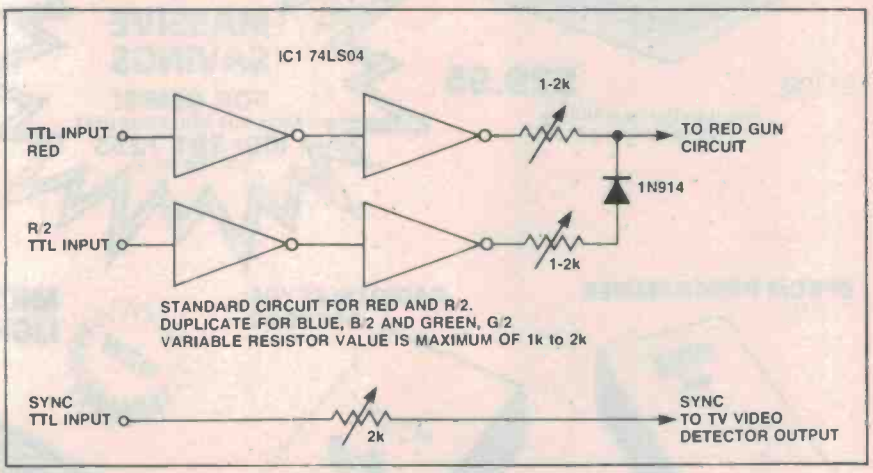
The Microbee Engineering Notebook suggests as one possible alternative for the interface, an open-collector inverter on page 12. My solution was to use the 74LS04

Below. The RGB interface card plugs in below the serial port. This board is not supplied with the conversion, you build it yourself.









Above. My prototype RGB interface card. It measures 85 mm long by 63 mm wide. The trimpot in the centre is the sync amplitude control.
Above right. The new colour card, fitted by Applied Technology, is mounted onto the base of the main board in the 'Bee.
Right. Circuit of the RGB interface card. The colour and half-colour signals are combined in the circuit shown. A pair of 74LS04 ICs provides sufficient gates to do the job.

inverter with a diode to isolate the outputs where they combine, as shown in the diagram. An oscilloscope will be required to set up the half-intensity RGB signals so that they are 50% of the RGB signals. The need to build this interface board is the worst aspect of the colour conversion. It should be supplied with the conversion and fitted inside the 'Bee, I think.

It should also be noted that the RGB-plus sync signal is not compatible with the normal TV. An RGB monitor is required, although most family colour TVs can be modified successfully.

Software testing

Two short programs are listed to assist in testing and demonstrating the colour capability of the Microbee. The first displays a standard set of colour bars to assist in aligning the RGB monitor. The second is a kaleidoscope using all of the colour com-▶

```
Program number one for the Microbee .. Colour Bars.
00100 REM .. Microbee Colour Bars ..
00110 LORES : PCG
00120 FOR N = 0 TO 14
00130     FOR C = 0 TO 7
00140     COLOR C : PRINT "????????";
00150     NEXT C
00160 NEXT N
00170 A1$ = KEY : IF A1$ = "" THEN 170
00180 HIRES : CURS 0
>
```

```
Program number two for the Microbee .. Kaleidoscope.
00100 REM .. Kaleidoscope .. for Microbee OS 5.22e
00110 REM .. Mike Hennessy .. Jan '84.
00120 PCG : LORES
00130 FOR K= 1 TO 10
00140 B = INT (RND*7) : COLORB B : REM background color
00150 CLS
00160     FOR J= 1 TO 10
00170         FOR N=1 TO 100
00180         X=INT (RND*959)
00190         Y=INT (RND*63)+129
00200         C=INT (RND*31) : COLOR C : REM foreground color
00210         CURS X : PRINT CHR (Y)
00220         NEXT N
00230     M=INT (RND*7) : COLORM M : REM Half mode color
00240     NEXT J
00250 NEXT K
00260 GOTO 130
>
```

mands. Both are self explanatory and useful as a demonstration of what the 'Bee can do.

Old operating system software

The new Microbee Colour BASIC is upwards compatible from earlier versions. Programs such as Chess, Invaders, Robot Man all run but without the enhancement of colour change from the default green foreground on black, unless of course you change these before the program is run. I would assume that the popular programs would be rewritten for colour and that users could obtain replacements, for a nominal fee, by returning the old tapes. (That'd be a good idea . . . Ed.).

Deficiencies

The worst deficiency as a result of this conversion is that you are still stuck with 128 PCG characters. As a result, your high resolution capabilities are very restricted, you are unable to utilize the full screen display potential that is there. Personally, I feel that the loss of some program RAM space in order to increase the number of PCG characters would be well worth it in terms of utilizing the latent graphics potential.

Next, there are no graphics commands to fill circles or triangles, or any shape for that matter, with colour. The inability to address alternative individual pixels, within the same character block, for colour change will make the development of these routines very interesting.

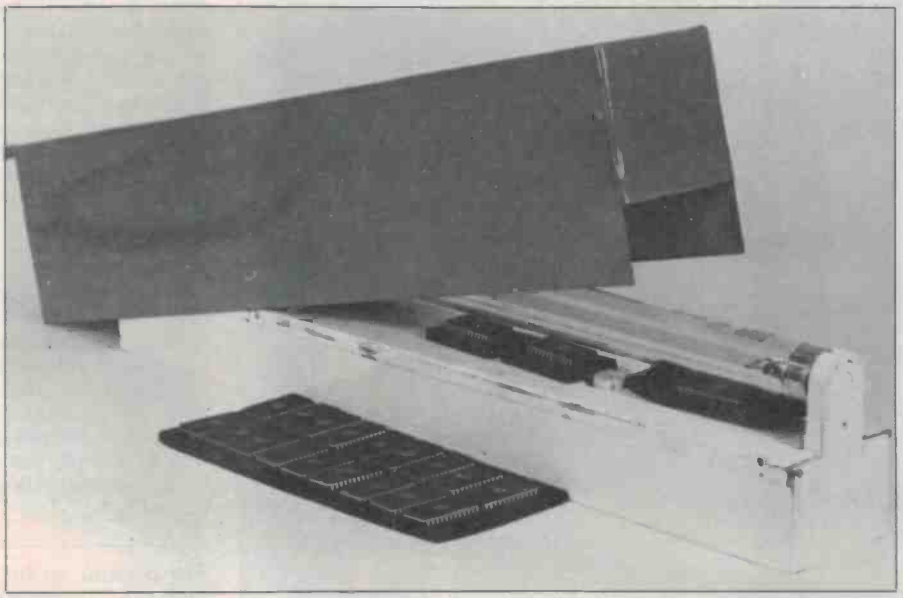
Conclusions

The enhancement to the VDU presentation by using colour on the Microbee can only be described as spectacular. The conversion puts the Microbee in the same league as more expensive personal computers using high resolution colour graphics, in my opinion.

The inclusion of Wordbee and the terminal communications in the conversion is an added bonus for users, and makes up for the lack of an RGB interface card for the TV.

Pangalactic EPROM eraser

Geoff Nicholls



This project is the perfect companion to our popular ETI-668 Microbee EPROM programmer, or any EPROM programmer for that matter.

FOR ANYONE developing and using EPROM-based software, the essential 'tools' for the task are an EPROM programmer and an EPROM eraser. We have described a number of EPROM programmers over the years: the ETI-643 Universal programmer (Dec '79), the ETI-686 PPI-based programmer (October '82) and the popular ETI-668 for the Microbee (Feb '83 and Jan '84). We have, however, not published an eraser for the popular and widely-used UV-erasable PROMs. This project rectifies that omission.

To 'erase' a UV-erasable EPROM, all you need do is place the IC's 'window' in a strong source of shortwave ultraviolet light with a wavelength of 2537 angstroms for a period determined by the UV source intensity. The data books recommended a mimimum integrated exposure (UV intensity times exposure time) for erasure of 15 W-sec/cm^2. For most types, this gives an erasure time of around 15-20 minutes using an ultraviolet lamp with a 12 mW/cm^2 rating, providing you stick the EPROM about 25 mm from the lamp during erasure.

First problem — find a UV lamp with appropriate wavelength output and power rating. We found a Philips type (G 15 T8) stocked by Circuit Components of 383 Forest Rd, Bexley, NSW 2207; (02) 59-3720. This is a 15 watt tube that fits a normal fluorescent lamp batten, which was neat because it solved the mechanical problems too.

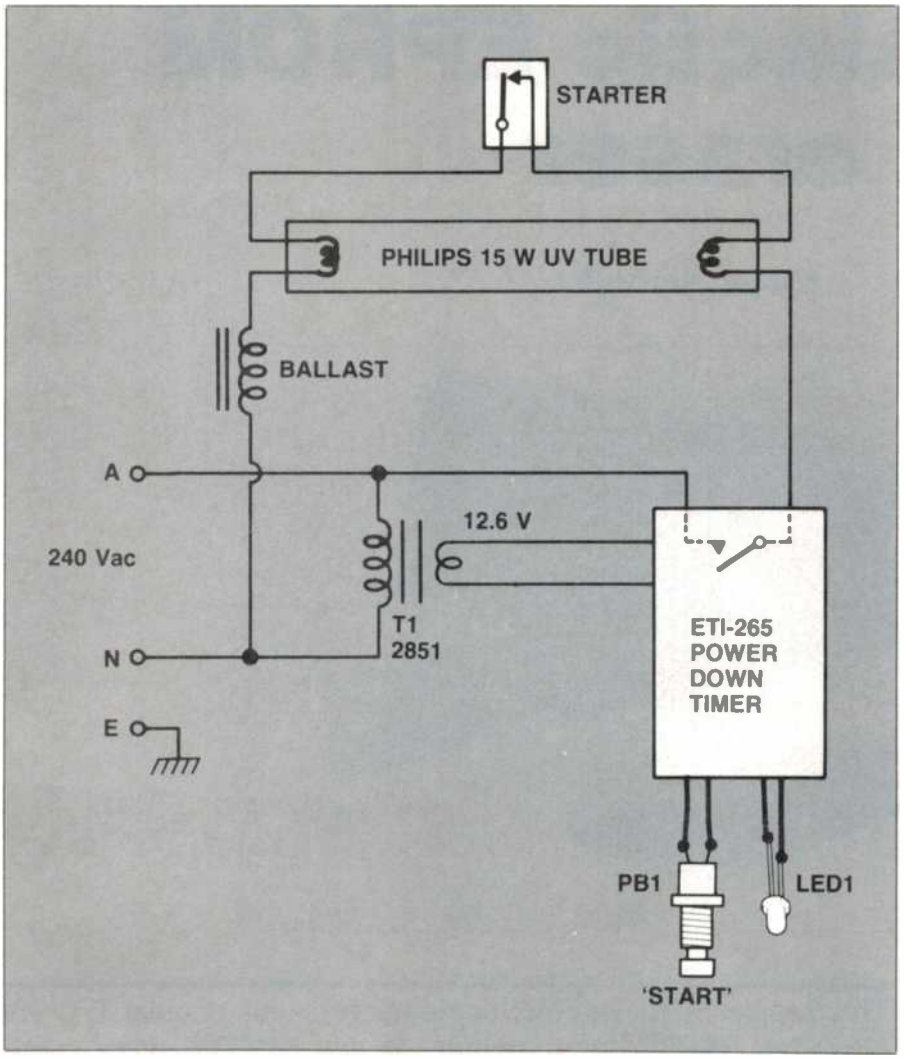
Next problem, an 'erasure timer'. Our ETI-265 Power Down Timer (July 1983) suits the requirement perfectly. In fact, use of this project in an EPROM eraser was mentioned in the article. With a little trial and error to test how critical the whole set up might be, it was found that a fair latitude of exposure time could be allowed. Ten minutes was found to be a minimum for 2716s, 2532s, etc and 30 minutes a reliable maximum.

The '265 timer fitted neatly inside a 15 W fluorescent light batten and the EPROMs could be sat beneath the tube at closer than the 25 mm distance recommended in the data books, especially if you leave the device stuck in its piece of conductive foam.

Where did that name *come* from? Fans of "The Hitchhikers Guide to the Galaxy" will recognise it instantly. The prefix 'pan' means "all", the suffix 'galactic' means "of the galaxy". So, you can erase any of the known UV-erasable EPROMs available in our galaxy.

Construction

For construction of the ETI-265 timer, refer to the article in the July 1983 issue. Before assembling the '265 board, use the blank board as a template to mark out its mounting hole positions on the lamp batten base. Then, using the components, mark out the mounting hole positions for the 2851 transformer. and the two-way terminal block. Drill the holes and clean off any burrs. Determine hole positions for the mains cable clamp grommet, the LED and pushbutton in the end of the batten furthest from the starter. Drill these holes and remove any burrs, as before. ▶



Attach leads about 100 mm long to the pushbutton and the LED and mount them. Mount the terminal block and the 2851 transformer. I mounted a piece of heavy cardboard beneath the transformer to prevent accidental access to the tranny via some pre-existing holes in the batten base.

Assemble the ETI-265 timer board, selecting C1, R1 and RV1 from Table 1 in the '265 article. Attach flying leads for the rectifier input (about 300 mm long) and the switched mains output (use 240 Vac rated wire here; determine their approximate lengths beforehand). Solder the flying leads to the board from the LED (watch polarity) and pushbutton. Mount the board in the batten, putting a piece of heavy card between the board and the batten base to cover pre-existing holes. Wire up the transformer secondary and then install the mains cable and mains wiring, as per the overlay/wiring diagram here. Check it all thoroughly.

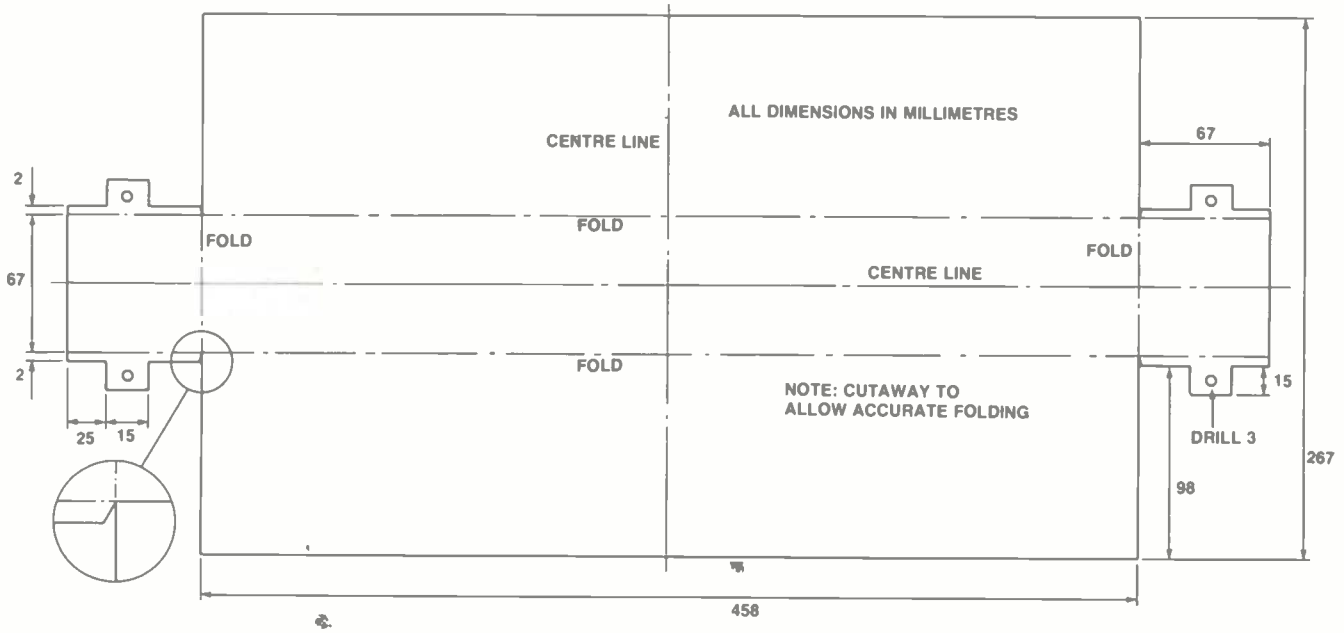
Now you can cut out and bend up the batten cove. I used self-tapping screws to hold it together. This cover just sits over the batten when in use.

For a trial test, put the lamp in the batten, plug in and switch on. Nothing should happen. Press the pushbutton and the lamp should light (as should the LED), going off at the pre-determined time later.

If all is well, you're ready to erase any of the popular UV-erasable EPROMs in the galaxy! ●

For a guide to buying components and kits, see SHOP AROUND this issue.

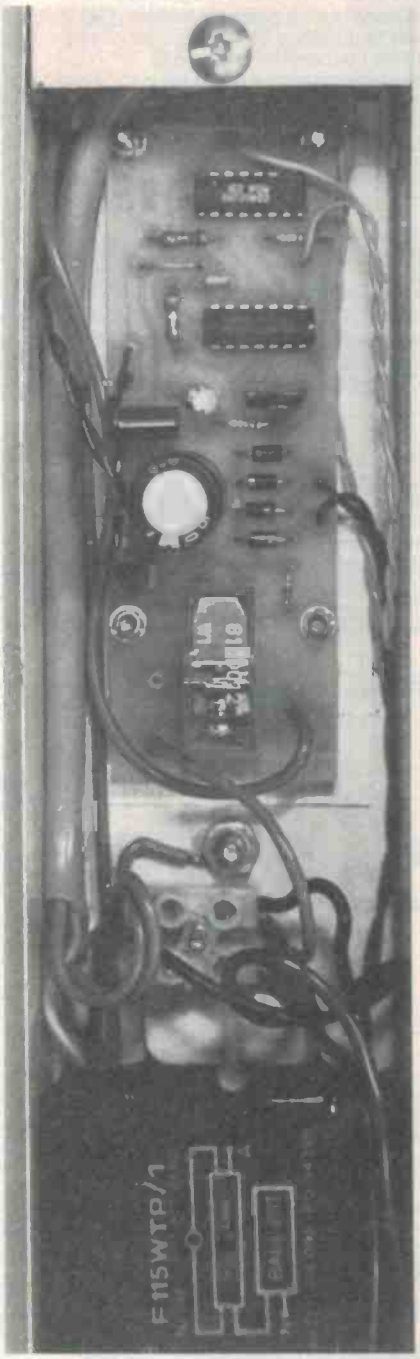
Batten cover. Dimensions for cutting out the batten cover.

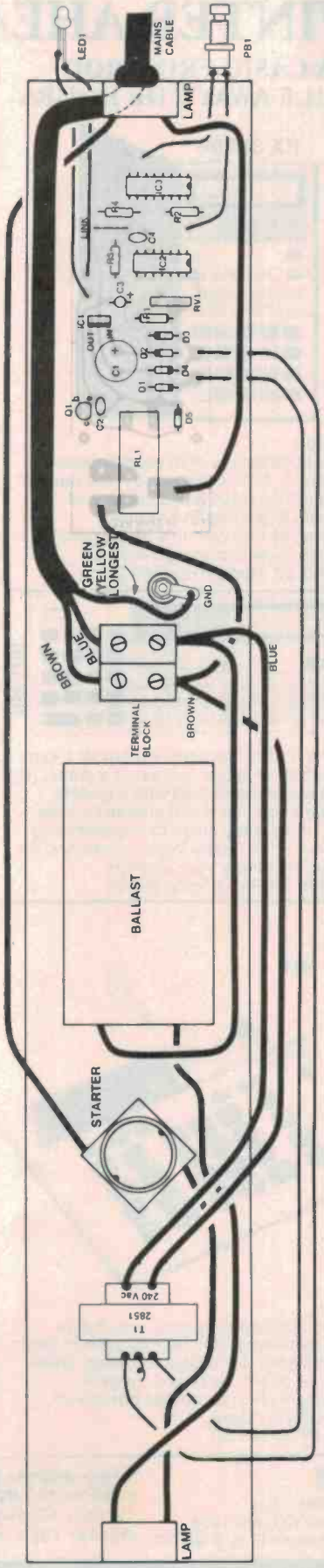


PARTS LIST — ETI-669

ETI-265 'Power Down' Timer project (board and electronics only); 15 W fluorescent lamp batten; Philips TUV 15 W UV (G 15 T8); transformer 2851; two-way terminal block; mains cable, 3-pin mains plug and clamp grommet; 4 x 25 mm bolts and nuts and washers; hookup wire — some 10 x 0.2 mm, some 24 x 0.2 mm; sheet of light gauge aluminium, 680 x 300 mm; four self-tapping screws, etc.

Price estimate: $60-$70





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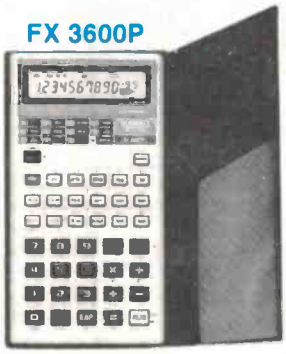

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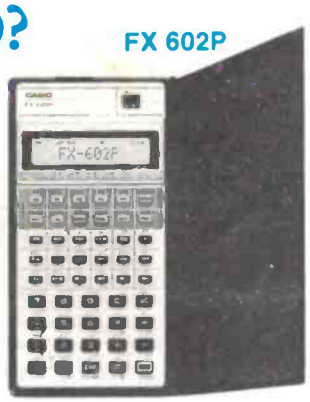

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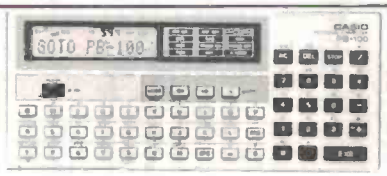

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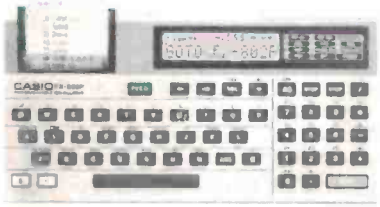

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A darkroom exposure/process timer Part 2

Peter Ihnat

This article completes the construction and assembly of the project, explains how it works and how to use it.

HAVING TESTED your power supply/relay/buzzer board and got it working, and assembled the '662a and '662d boards to the front panel and completed their wiring up, next thing to tackle is the mains wiring.

Connect the mains input exactly as detailed in the wiring diagram here but, as mentioned previously, leave the mains connection to the relay until the very last.

At last, the *moment of truth*. Switch the device on. All the displays should come on briefly and then 00.00 should appear on the display. If all is well, UNPLUG THE UNIT FROM THE MAINS and finally wire the mains connections as required to the relay.

The remote unit can now be assembled if required. Two pushbuttons are simply soldered onto the pc board which then mounts into the bottom half of the small plastic case. If the recommended case is used then four bolts will self tap into the mounting pillars provided for this purpose. On the prototype, I spaced the board off these pillars by the thickness of three washers since the buttons are a bit too short to come through the top of the unit.

The stereo 3.5 mm jack plug can be connected to the unit by a suitable length of 3-core cable, for example figure-8 shielded cable. The length will depend on the distance from the enlarger to the wet area in your darkroom.

One last point of interest — keep all leads clear of the ceramic transducer. The particular one I used is a vibrating case type and loses volume if anything touches it.

Using it

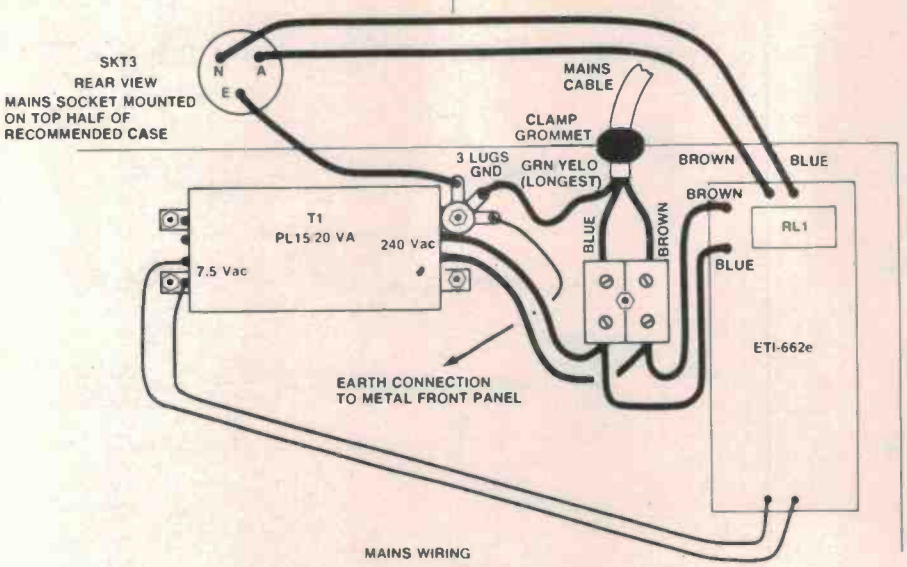
Firstly, plug your enlarger (or colour head power supply) into the output socket on the back of the unit. If your processing area is away from the enlarger, plug the remote unit in and position it somewhere convenient in that area. Now, let's program the unit.

Each timer in the unit must be programmed separately — actually, only the time currently being displayed can be changed. The SELECT button is used to select which timer is currently being displayed (the two LEDs below the main display indicate which). All you need to do is press MINS or SECS to set the required time — holding the button down causes the time to increment automatically. The FWD and BACK buttons allow each of the five exposure or ten process times to be accessed and programmed.

Let's look at a programming example. Assume we need 10, 7 and 5 seconds to be programmed as the three exposures to produce a certain print. To process it, the times are: four minutes developer, one minute for stop bath, four minutes in the fixer and 30 minutes wash.

Press SELECT a few times until the 'exposure' LED comes on.

Use SECS to set 00.10 (10 seconds) on the display.



Press FWD (forward) to program the next time.

Use SECS to set 00.07 on the display. Press FWD.

Use SECs again to set 00.05 on the display.

The exposure timer is now ready for use. If you press BACK at any time then your previous entries can be checked or even modified. If the GO/STOP button is pressed, the enlarger will come on for the time period currently being displayed. Since we would like to start the exposure sequence with the first entered time, press exposure RESET twice (within 1/2 sec) and the first exposure time will be displayed.

Exposures may now commence and a press of ON/OFF will switch the enlarger on for the length of time being displayed. At the end of this time, the enlarger will switch off and the next programmed time will be displayed. After you have finished the three exposures, the timer automatically resets to the first programmed exposure time (because the next one hasn't been set and is therefore 00.00).

If during an exposure you press the ON/OFF button, the enlarger will switch off. Pressing the button again will result in the exposure continuing from where it stopped. If you want the particular exposure step to start from scratch, simply press RESET before pressing ON/OFF. Remember that pressing RESET twice within 1/2 second resets the entire exposure sequence to the first programmed time.

One very important function of an exposure timer is to allow the operator to switch the enlarger ON indefinitely so that a negative can be loaded and focussed. This is achieved by pressing ON/OFF twice within 1/2 second. To switch the enlarger OFF again, press either RESET or ON/OFF.

Now for the process timer. Press SELECT until the 'process' LED lights. Use MINS, SECS and FWD to set the following times — 04.00, 01.00, 04.00 and 30.00 as previously described. The RESET button here operates in a similar manner to the exposure RESET. The GO/STOP button is used to start and stop the timing process. Note that at the end of each step, the timer stops and needs to be restarted (by pressing GO/STOP on either the main or remote units).

If you want to use one of the built-in process sequences, simply press PROG and then either BACK, FWD, MINS or SECS. Table 1 lists which processes are available but to help you remember where they are, stick a small Scotchcal label on the front of the unit (see photograph). The processes ▶

can be used exactly as stored or you can modify any of the steps to suit your own processing methods (note that modifications are not permanent and are lost as soon as the unit is switched OFF).

Another press of SELECT blanks the 7-segment display and allows only the LED array to be displayed. If total darkness is required, another press of SELECT blanks the displays completely (the timers still work as described even though the displays are OFF). Since you may want to use this mode quite frequently, attach those little sticky pads (you know, the ones that glow in the dark) onto the tops of the four right-hand buttons. This makes them easy to find in the dark and stops you from pressing the wrong button.

SUMMARY OF KEYBOARD FUNC-TIONS

SELECT: Pressing this button places the timer in one of four modes. These are:

1. display off
2. display current exposure time
3. display current process time
4. display analogue process time (bargraph only). Changes to stored entries can only be made to the one currently being displayed.

SECS: Used to modify the 'seconds' part of the currently displayed time. A quick press increments it by one second. If held down, the time increments at an accelerated rate.

MINS: As for SECS except that the 'minutes' part of the currently displayed time is incremented.

FWD: This displays the next stored time which can be either one of five exposure or 10 process times, depending on the mode set by the SELECT button.

BACK: As for FWD except that the previous entry is displayed.

PROG: This is used to select one of the pre-programmed processes as listed in Table 1. When pressed, the display shows 'PROG'. Pressing one of BACK, FWD, MINS or SECS loads the corresponding processing times (any other button cancels this function).

GO/STOP: This pushbutton works in toggle fashion. When pressed, the current process time (whether displayed or not) starts to decrement. If pressed again before zero is reached, the timer stops. Another press continues the timing from where it stopped.

The internal buzzer sounds 15 seconds before the end of the current timing period to indicate that chemicals may be drained from the processing tank and those for the next step poured in. At the end of the time period, the buzzer sounds for one second and the next process time is loaded. Timing continues with a press of GO/STOP.

RESET (proc): When pressed, the current process time is reset to its original value. This is a useful function since accidents do happen and GO/STOP could be pressed before things are set to go. A single press of RESET sets the current time to its original value.

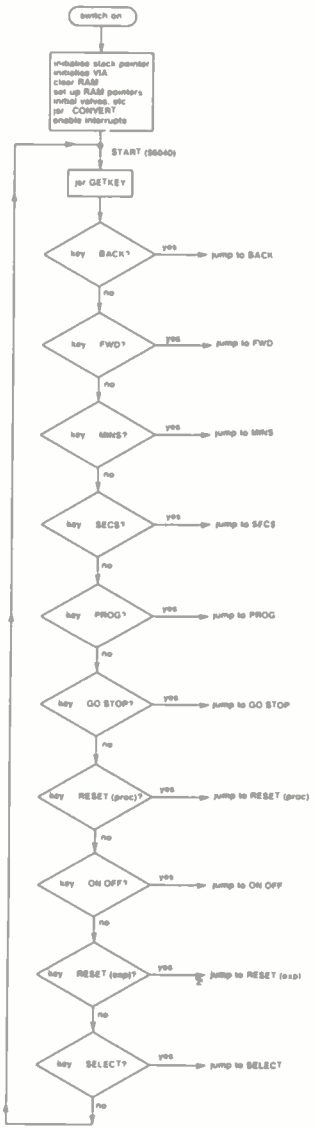
If the button is pressed twice within 0.5 second, the timer resets to the very first process time. This is used most frequently to initialise the timer after just entering all the steps for some process.

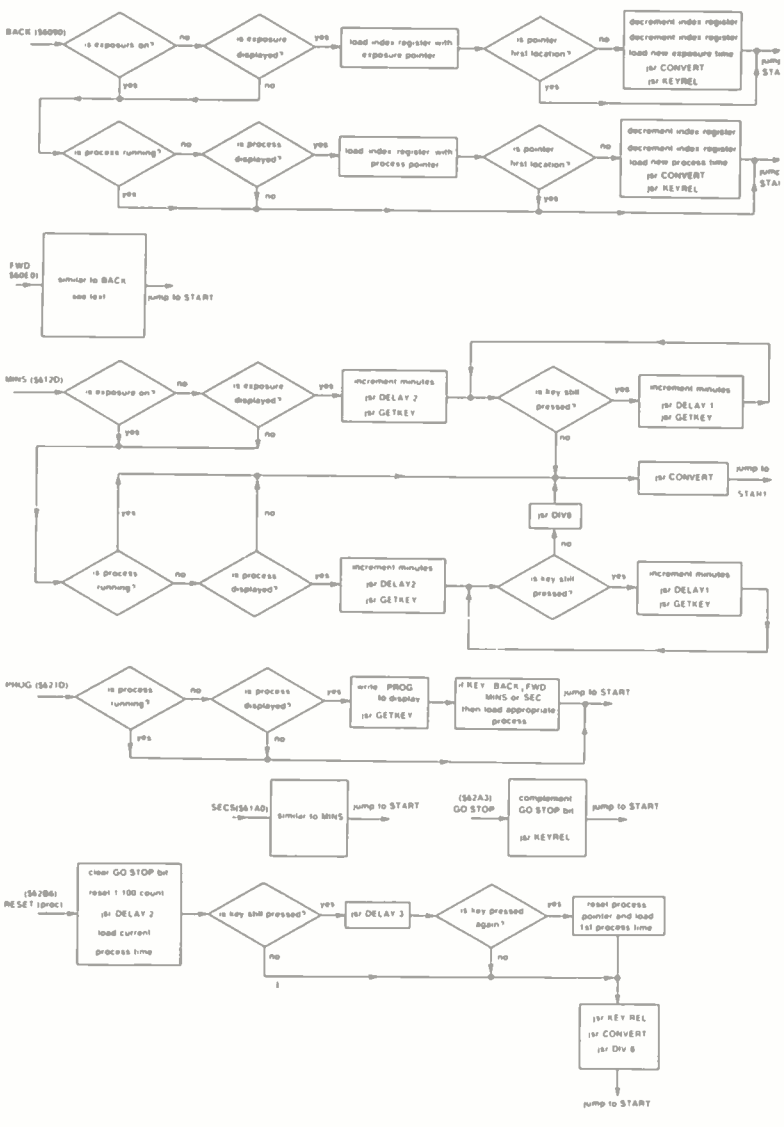
ON/OFF: Like the GO/STOP button, this works in toggle fashion. When pressed, the internal relay operates and applies power to the enlarger. The current exposure time (whether displayed or not) decrements and when zero is reached, the enlarger switches off. The timer can be interrupted by a press during the timing period resulting in the enlarger turning off. Another press continues timing.

When the enlarger needs to be switched on indefinitely for focussing purposes, press ON/OFF twice within 0.5 second. It can be switched off by pressing either RESET (exp) or ON/OFF. Note — due to the way the focus function is implemented, be careful when exposing prints. *One quick press* of the ON/OFF button is recommended since a sloppy press could leave the device in focus mode!

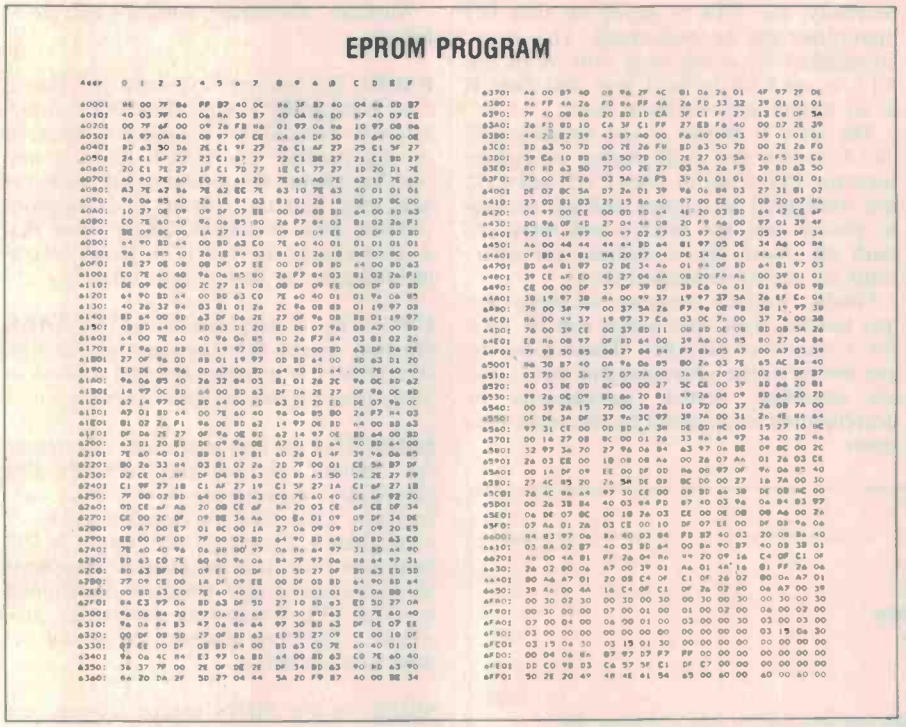
RESET (exp): As for RESET (proc) except the exposure timer is involved.

Figure 1.





EPROM PROGRAM

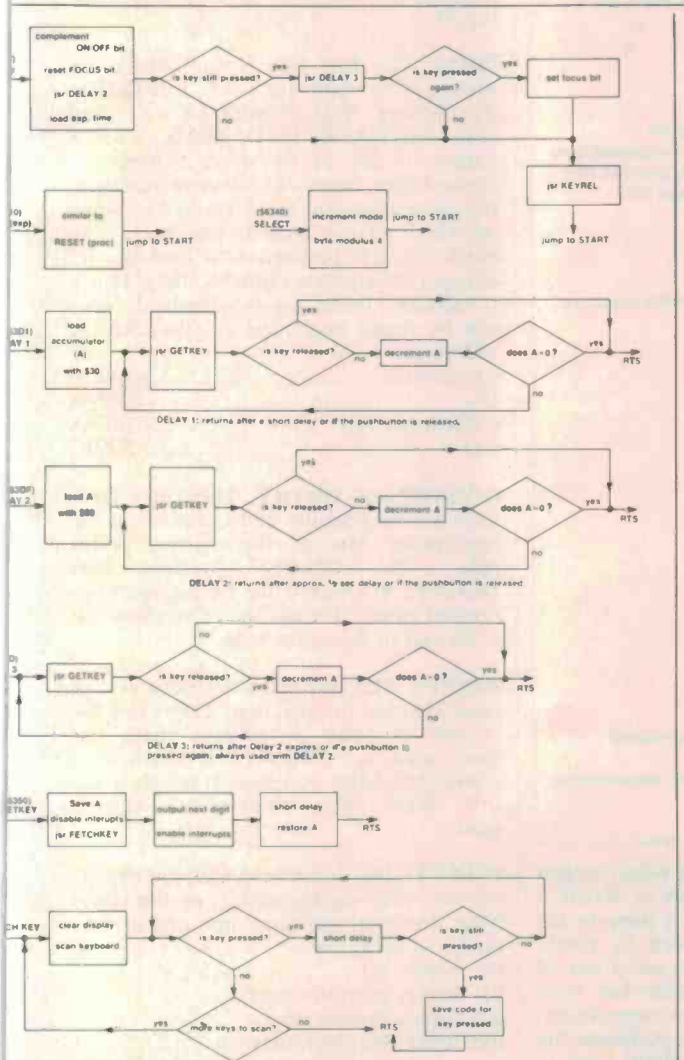


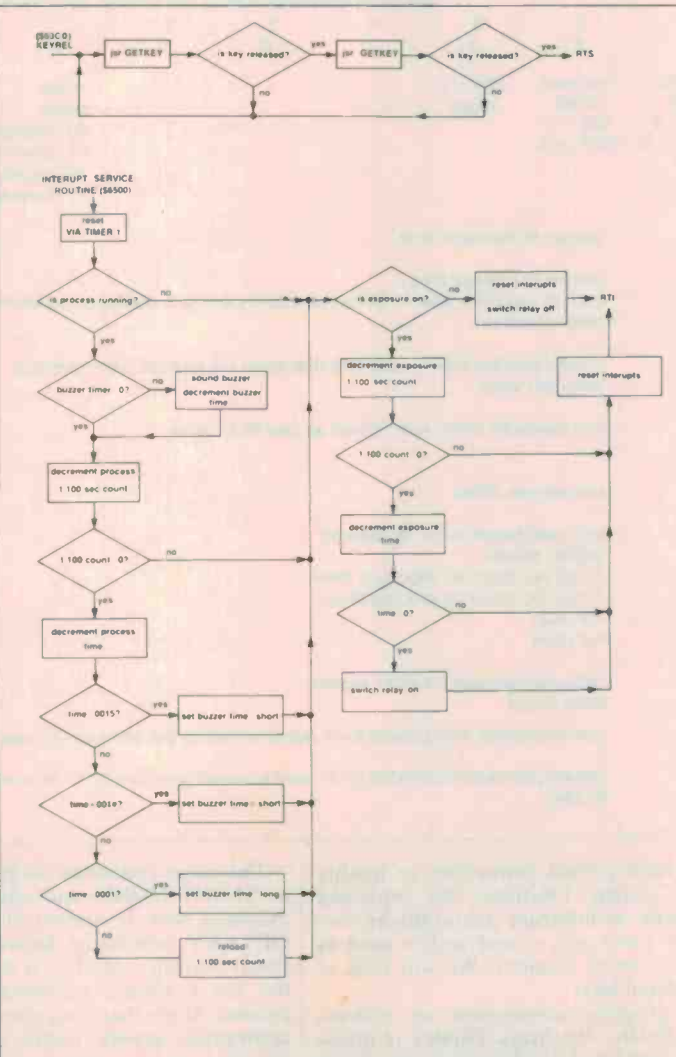
Software operation

The ETI-662a General Purpose Microprocessor may be a versatile device but it can't do a thing unless it has been programmed for some intended task. The flow chart for the Darkroom Timer program is shown in Figure 1 and a hex listing is given elsewhere in this article. Unfortunately, a complete assembler listing can not be given but reference can be made to the hex listing while reading the following descriptions. Note also that the program can be shortened considerably if it was required to fit into a 1K or 2K-style EPROM. Luckily, the General Purpose microprocessor uses a 2732 (4K) EPROM which has more than enough room — besides, the program is easier to understand and follow in its present form.

The General Purpose microprocessor assumes that ROM is located between $6000 and $6FFF (the $ sign meaning hex) and the VIA's (Versatile Interface Adapter) registers are between $4000 and $400F inclusive (see ETI-662a project, April '84 for a discussion on memory decoding).

At switch-on, a hardware reset is performed and the microprocessor commences 'processing' by fetching the *address* of the first instruction from the ▶





last two locations in memory. These two locations are 6FFE and 6FFF and contain 60 and 00, respectively.

The complete program can be broken down into five sections comprising *initialisation, main command loop, pushbutton service* routines, *housekeeping* subroutines and *interrupt service* routine.

Basically, after switch-on the initialisation is performed and then the main command loop is entered. In this loop the displays are multiplexed and a check is made for a pushbutton press. The microprocessor exits the loop only briefly to respond to either a pushbutton press or an interrupt. In fact, the microprocessor spends most of its time in the command loop.

The pushbutton service routines simply set or reset certain status bits or modify various storage locations. As explained last month, an interrupt (mains driven) occurs 100 times per second and is used as the main timing element. We will look at this in detail later.

The program commences at address $6000. Firstly, the Stack Pointer is initialised so that return addresses can be saved and retrieved when subroutines are called. Secondly, the VIA is set-up so that I/O operations can be performed. This is accomplished by configuring Port A of the VIA as an 8-bit outport port and Port B as six output and two input lines.

The How It Works in last month's article describes the multiplexing procedure used for I/O. Control lines CA2 and CB2 are configured as outputs and are set low to ensure that the buzzer and relay are both off. Next, the conditions for interrupts are set-up (described later).

Finally, various memory locations are 'pre-loaded' with data which will be used for a variety of purposes. These locations are shown in the accompanying panel and are modified, tested, incremented or decremented as required by the main program.

'PRE-LOADED' MEMORY LOCATIONS

Address	Function
0000	display storage area: mode indication
0001	display storage area: bargraph segments
0002	display storage area: tens-of-seconds
0003	display storage area: seconds
0004	display storage area: minutes
0005	display storage area: tens-of-minutes
0006	current status byte: a '1' in a bit position indicates that the timer is running; the exposure timer is in FOCUS mode when both bits 6 and 5 are '1'.

bit: 7	6	5	4	3	2	1	0
X	X	X	0	0	0	X	X
process timer GO = 1 STOP = 0	exposure timer ON = 1 OFF = 0	FOCUS mode				mode select 00: display off 01: display exposure time 10: display process time 11: bargraph only	

0007	
0008	pointer to exposure time
0009	
000A	pointer to process time
000B	current exposure time — this is the quantity which is decremented when the exposure
000C	timer operates
000D	
000E	current process time — decremented when the process timer operates
000F	bargraph value
0010	
to	five exposure times, each stored as four BCD digits
0019	
001A	
to	ten process times
002D	
002E	key: pushbutton currently pressed
002F	display pointer
0030	1/100 sec count for exposure timer
0031	1/100 sec count for process timer
0032	not used
0033	not used
0034	
0035	temporary storage for index register
0036	beep length
0037	
0038	current process time divided by 8; decremented by the interrupt servicing routine
003A	
003B	current process time divided by 8; used to reload locations 37 to 39 when decremented
003C	to zero

The main command loop which begins at START ($6040) and ends at $608F is executed next. It consists of a jump to the GETKEY subroutine followed by conditional branches which test to see if one of the ten keyboard pushbuttons has been pressed. If so, then execution jumps to the appropriate service routine, performs the required function and then jumps back to the command loop.

Basically, the service routines operate as follows.

BACK: The current exposure or process time is normally loaded from the memory location pointed to by the exposure or process pointer. The BACK function simply decrements this pointer and loads the new time into the current time locations ($000B, 000C or $000D, 000E). Note that it also checks to see if it hasn't decremented past the first stored entry.

FWD: This is very similar to the BACK function except that the exposure or process pointer is incremented and a check is made to see if the last entry isn't passed.

MINS: This particular routine increments the 'minute' part of the currently displayed time making use of two delay subroutines. DELAY2 produces a delay of about half a second. If the button is still held after this, then the minutes increment at an increased rate which is determined by DELAY1, a relatively short delay subroutine. The flow diagram shows the actions of these delays.

SECS: As for MINS except seconds are incremented and reset to zero after passing 59.

PROG: The first task performed by this routine is to write the letters P-R-O-G to the displays. Next, it waits for a press of either the BACK, FWD, MINS or SECS button; if any of the other buttons are pressed they cause execution to return to the main command loop. Then, depending on which of the buttons was pressed, a block move is performed to load the required colour process into locations $001A to $002D. These pre-programmed times can be found beginning at the following addresses:

Ektaprint 2. .....$6F80
E6. .....$6F94
Cibachrome AII. $6FA8
C41. ..... $6FBC

GO/STOP and ON/OFF: These two functions are very similar and complement the appropriate bits in the 'current status byte'. The ON/OFF function uses DELAY2 to check if the button has been pressed twice. If it has then the 'focus' bit is also set in the status byte.

RESETS: The two reset functions are almost identical in operation. They reset the current exposure or process times but once again use DELAY2 to check if a double press has occurred. If so, then the first stored entry becomes the current time.

SELECT: This function simply increments the two least significant bits of the status byte. This puts the timer into one of four modes of operation:
00: display off
01: display exposure time
02: display process time
03: display bargraph only

There are seven principal subroutines ▶

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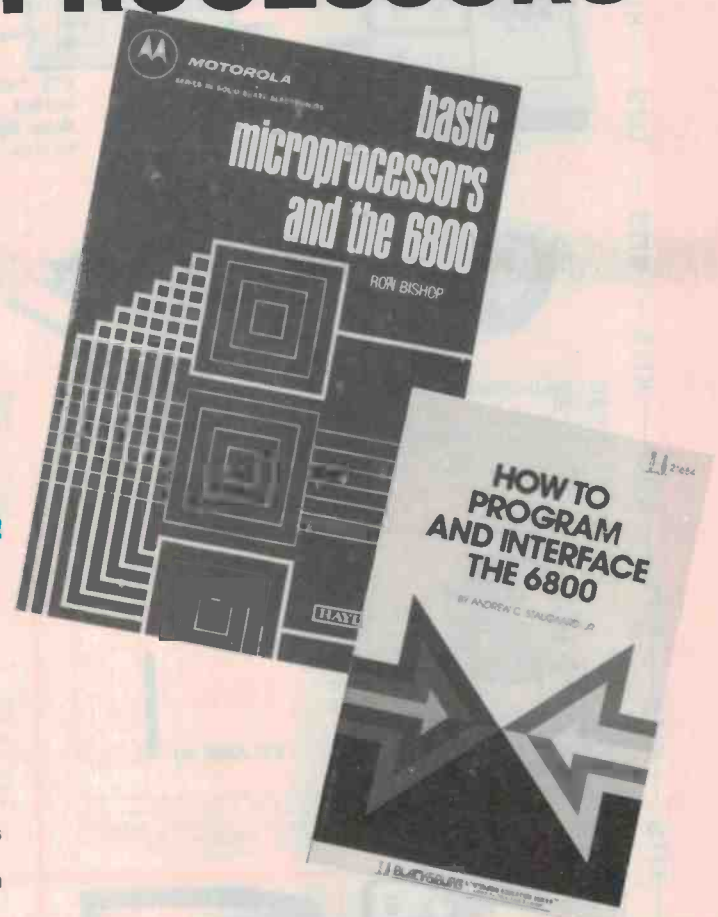

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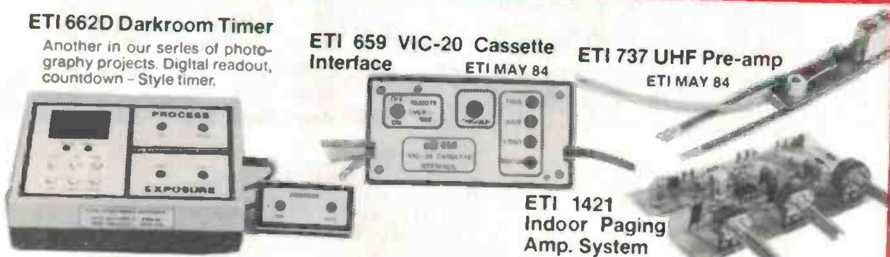

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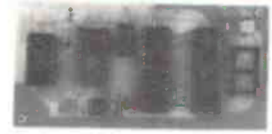

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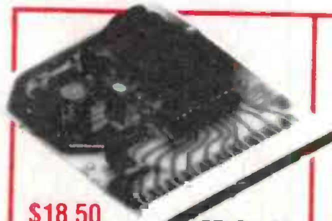

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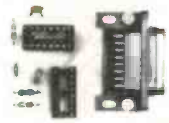

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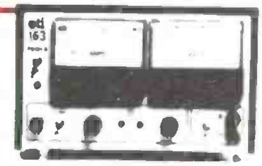

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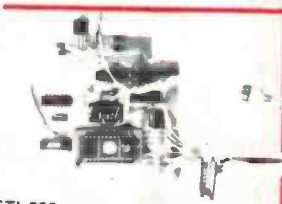

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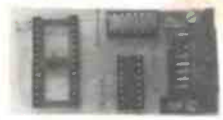

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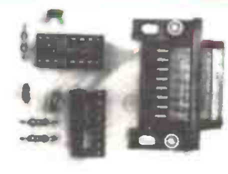

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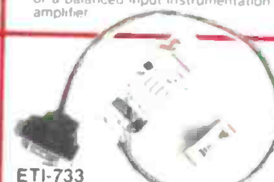

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which are used by many of the service routines. The GETKEY subroutine is probably the most important of these since it multiplexes the displays and scans the pushbuttons to determine if one has been pressed. The multiplexing procedure has been described in previous articles and will not be described here.

Depending on the pushbutton pressed, the subroutine returns with one of the following values in the KEY byte (location $002E). **BACK:** $9F, **FWD:** $AF, **MINS:** $5F, **PROG:** $B7, **GO/STOP:** $BE, **RESET (proc):** $BD, **ON/OFF:** $7E, **RESET (exp):** $7D, **SELECT:** $77, no pushbutton pressed: $00.

The key release (KEYREL) subroutine is one that is used at the end of most of the service routines. It prevents the microprocessor from returning to the main command loop until the currently pressed pushbutton is released, otherwise execution will return to the command loop and almost immediately jump to the keyboard service routine again, back to the command loop, etc until the button is released.

Three of the subroutines produce delays of varying degrees. DELAY1 simply produces a short delay (fraction of a second) and is used to set the automatic incrementing speed when either minutes or seconds are set. DELAY2, about half a second, is the delay used when checking to see if RESET or ON/OFF have been pressed twice in quick succession.

Note that a return-from-subroutine (RTS) is performed if either the required delay expires or if the currently pressed pushbutton is released. The two cases are distinguished by checking the KEY byte where a 00 indicates that the key has been released. DELAY 3 is used only after DELAY2 and basically continues DELAY 2 until it times-out or a pushbutton is pressed again (the double press of RESET or ON/OFF).

The remaining subroutines are **CONVERT** and **DIV8. CONVERT** is called at the end of programs which produce changes to the quantities being displayed; for example, after decrementing the displayed time or incrementing the seconds part of the time, etc. It separates the current time into its four individual digits and looks up the corresponding 7-segment data for each digit from the look-up table stored between $6FDO and $6FD9. This data is then stored in the correct place in the display storage area, ready to be multiplexed to the displays.

DIV8 is used to divide the current process time into eight equal intervals which define the bargraph 'step'. In actual fact, the subroutine multiplies the minutes by 60, adds the seconds, multiplies by 100 and divides the lot by eight. The multiplication by 100 is to convert the time into hundredths of a second so that it can be decremented each time an interrupt occurs.

The interrupt service routine performs the actual time keeping functions as well as operating the bargraph display and switching the relay and buzzer outputs. The 100 Hz pulses from the mains are fed into the VIA's CB1 control line which is configured as an interrupt input. Unfortunately, it isn't possible for this line to be an independent interrupt line (independent in this case meaning that reading or writing to port A and port B of the VIA does not clear any status bits which indicate that a pulse has occurred on the line).

Independent interrupts are possible on the CA2 and CB2 lines but these are already being used to control the buzzer and relay. The CB1 line is really a handshake line used when full handshaking is required in I/O operations.

So, in the present project, when a timing pulse is produced by the mains, the CB1 line sets an interrupt bit in register 13 of the VIA which in turn pulls the IRQ line to the microprocessor low indicating that an interrupt condition exists. However, if this occurs precisely when the GETKEY subroutine outputs to the display or inputs from the pushbuttons, the very act of inputting and outputting *resets the interrupt* condition resulting in the interrupt being ignored. I found this out the hard way when the prototype lost three seconds per minute — not good for a timer!

On closer inspection, I noticed that CB1 can be used as an external clock input to a shift register inside the VIA. This operates as follows: when a byte is loaded into the shift register, an internal modulo-8 counter is reset. Then the next eight pulses into CB1 move data around the register and after eight shifts, an interrupt is generated.

It seemed OK on the surface but when implemented the prototype still lost time — approximately one second per hour. It seems that the external clock pulse is ignored when it switches state simultaneously with the microprocessor E signal. This is not referred to in the 6522 data sheet and I am still investigating the problem.

To produce a reliable timing signal, I implemented two interrupt modes — the normal 'handshake' interrupt for CB1 described above and the Timer 1 one-shot mode. The latter is initialised when a number is loaded into the timer which then decrements at 1 MHz (frequency of the E signal). An interrupt is generated when it reaches zero.

If, however, the timer is reloaded before it times-out, then the interrupt is prevented. I used this 're-triggerability' property of the timer to act as a 'missing interrupt' detector. Basically, it operates as follows. The number which is loaded onto the timer produces a delay of just over 1/100 second and is initialised at the beginning of the interrupt service routine. Program execution continues normally until the 100 Hz signal produces the next interrupt.

Once again, the timer is initialised preventing it from interrupting as well. However, if the normal mains generated interrupt is missed, then the timer times-out and produces the interrupt *instead*, thus ensuring that accurate timing is maintained.

The rest of the interrupt routine merely decrements the current time and switches the two outputs as required. The flow diagram shows this clearly. ●

BACK: KODAK EKTAPRINT 2 (38°C)

1.	PREWASH	30 secs
2.	DEVELOP	2 min. 30 sec.
3.	STOP	30 secs
4.	WASH	30 secs
5.	BLIX	30 secs
6.	WASH	30 secs
7.	WASH	30 secs
8.	WASH	30 secs
9.	WASH	30 secs

FWD: KODAK E-6 (37.8°C)

1.	1ST DEVELOP	7 mins.
2.	WASH	1 min.
3.	WASH	1 min.
4.	REVERSAL	2 min.
5.	COLOUR DEV.	6 min.
6.	CONDITIONER	2 min.
7.	BLEACH	7 min.
8.	FIXER	4 min.
9.	WASH	6 min.
10.	STABILISER	1 min.

MINS: ILFORD CIBACHROME AII (24°C)

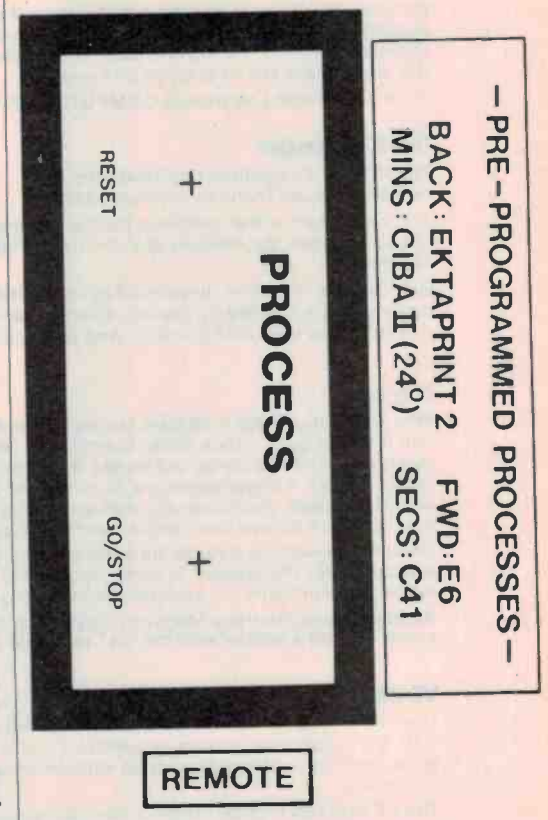
1.	DEVELOP	3 min.
2.	WASH	30 sec.
3.	BLEACH	3 min.
4.	FIX	3 min.
5.	WASH	3 min.

SECS: KODAK C-41

1.	DEVELOP	3 min. 15 sec.
2.	BLEACH	6 min. 30 sec.
3.	WASH	3 min. 15 sec.
4.	FIXER	6 min. 30 sec.
5.	WASH	3 min. 15 sec.
6.	STABILISER	1 min. 30 sec.

The above processes are preprogrammed in the darkroom timer. They can be accessed by pressing PROG, followed by either BACK, FWD, MINS or SECS, as appropriate.

TABLE 1.

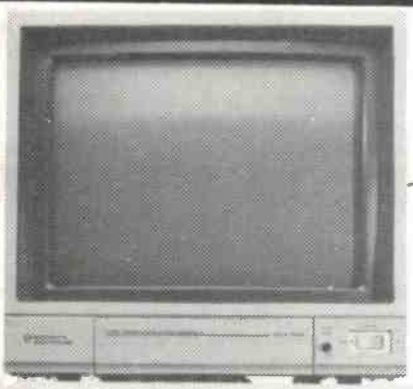


NOTE: front panel artwork is on page 161.

Dick Smith

COMPUTER CITY

For range and value, we can't be beaten!



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Why waste hundreds of dollars buying an Apple computer when you can buy The Cat . . . Dick Smith Electronics' latest computer masterpiece! It's twice as fast as the Apple IIe. It has a bigger and better BASIC. A larger keyboard. Super hi-res colour graphics. More sound channels. Just compare the two computers and judge for yourself! (Ask for our free comparison brochure).

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And because we import direct, there's no middleman to force up the price. It really is outstanding value for money. Again from EA: "If you want a machine which is compatible with the Apple II and which is supported by a reputable dealer, the CAT with emulator is good value".

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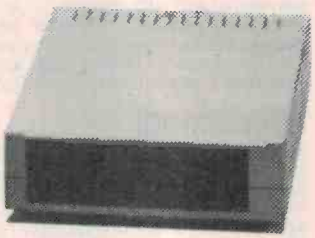
Cat X-7500

$699

That's far less than half the price of the Apple with similar features!



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Package price **$299**

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A 762/KT

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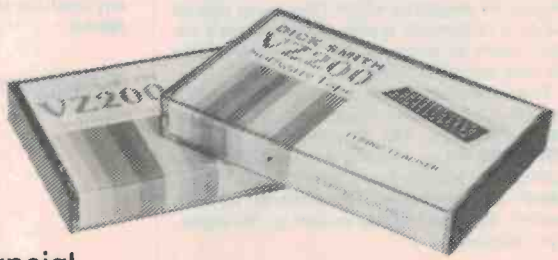
* Arriving End June

VZ-200 Software



Financial

X-7261 Portfolio Management	$12.50
X-7262 Discounted Cash Flow Analysis	$12.50
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X-7254 Golf/Tennis Lesson	$12.50
X-7255 Introduction to BASIC	$12.50
X-7256 Elementary Geometry	$12.50
X-7257 Speed Reading	$12.50
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X-7259 Mailing List	$12.50
X-7280 Hex Utilities	$12.50
X-7285 Spellomatic 1 & 2	$12.50
X-7286 Spellomatic 3 & 4	$12.50
X-7287 Flashcard 1 & 2	$12.50
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X-7232 Poker	$12.50
X-7233 Hangman	$12.50
X-7234 Slot Machine	$12.50
X-7235 Blackjack	$12.50
X-7236 Circus	$12.50
X-7237 Biorhythm	$12.50
X-7238 Horse Racing	$12.50
X-7239 VZ-Invaders	$12.50
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X-7243 Hoppy	$12.50
X-7244 Super Snake	$12.50
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X-7248 Asteroids	$12.50
X-7264 Tennis	$12.50
X-7266 Planet Patrol	$12.50
X-7268 Ladder Challenge	$12.50
X-7270 VZ Panic	$12.50

Plus

X-7249 Air Traffic Controller	$19.95
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Coming Soon

WORD PROCESSOR (TO SUIT VZ-200)

DICK SMITH ELECTRONICS

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A762/LL

Next month — COMMODORE COLUMN

Because of the growth in the number of people using Commodore computers of one kind or another, we have decided to widen the scope of this column from next month. So it's goodbye VIC-20, hullo Commodore.

As before, we are after your contributions for the column. We are particularly interested in utility programs that put your machine through its paces, but please, please, please, don't send us any more Space Invader substitutes!

Preference will be given to VIC-20 or Commodore 64 programs which have been printed out on a reasonable quality printer. There's too much room for errors to slip in when you write out your programs by hand.

This is also the last month we are offering the VIC-20 expansion board as a prize. **Computer Technics, 123 Clarence St, Sydney** NSW 2000 will be sending their Australian designed and manufactured board to **Jan Desmond of Rochedale, Queensland** for this month's 'Memory mapped screen for 3K expansion' program.

BASIC HELP

This is a two part program for people interested in the graphics aspects of programming.

The first part (up to line 81) is a decimal to eight- bit binary converter. The program waits for a decimal number to be input and then gives the binary equivalent.

The second part converts an eight by eight matrix from binary to the decimal equivalent used in hi-res graphics. The matrix is built up by eight-bit rows.

Two keys are used for editing; the 'DEL' key erases the last bit and the 'U' key the last line. Note that only the '1' key will cause a '1' to appear, while any other key (except the edit keys) will cause a '0' to appear.

T. Warburton, Fowlers Gap Station, Broken Hill NSW

```
 5 POKE36879,15:PRINT"■■■■■■■■■■--BASIC HELP--":PRINTTAB(10)"■■■BY"
 6 PRINTTAB(4)"■■■■T.WARBURTON"
 7 FORT=0TO3000:NEXT
 10 PRINT"■■":POKE36879,15:PRINT"■■■■■■1--DECIMAL TO BINARY
 11 PRINT"■■■2--GRAPHIC'S AID"
 15 GETB$:IFB$=""THEN15
 16 IFB$="2"THEN89
 17 PRINT"■":PL=7914:CO=38634:NO=0:FORT=7TO0STEP-1:POKEPL-T,48
 18 POKECO-T,1:NEXT
 20 INPUT" INPUT NO";A
 21 IFA>255THEN81
 22 PRINTTAB(176)A"="
 25 FORT=7TO0STEP-1:B=A/2↑T:IFB=>1THEN50
 30 NEXT
 40 GOTO60
 50 POKEPL-T,49:A=A-2↑T:GOTO30
 60 PRINT"■■■■■ANOTHER?"
 65 GETA$:IFA$=""THEN65
 70 IFA$="Y"THEN17
 80 GOTO4000
 81 PRINT"■■■■■■0-255 ONLY":FORNM=0TO1000:NEXT:GOTO17
 89 PRINT"■■":P=0:M=0
 90 Q=7884+P:W=38604+P:E=Q+22:R=7891+P:A=0:O=38648+P
 100 FORT=0TO7:POKEQ+T,48:POKEW+T,7:NEXT
 110 FORY=0TO7:POKEE+Y,30:POKEO+Y,1
 115 GETA$:IFA$=""THEN115
 117 IFA$=CHR$(20)THENY=Y-1:GOSUB1000:POKEE+Y+1,32:POKEQ+Y,48:POKEE+Y,30:GOTO115
 118 IFA$="U"THEN1500
 120 IFA$="1"THENPOKEQ+Y,49:POKEW+Y,7
 125 POKEE+Y,32
 130 NEXT
 140 FORD=0TO7:C=PEEK(R-D):IFC=49THENA=A+2↑D
 145 NEXT:PRINT"■■■■■■■"TAB(82+P)"="A
 150 P=P+22:IFP=176THEN2000
 155 GOTO90
 1000 IFY=-1THENY=0
 1001 RETURN
 1500 IFP=0THEN90
 1501 P=P-22:FORH=0TO30:POKE7874+P+H+22,32:NEXT:GOTO90
 2000 FORG=0TO7:FORI=0TO7:L=PEEK(7884+I+M):IFL=49THENPOKE7884+I+M,160
 2005 IFL=48THENPOKE7884+I+M,32
 2010 NEXTI
 2015 M=M+22:NEXT
 3010 PRINT"■   ■■ANY MORE?"
 3020 GETA$:IFA$=""THEN3020
 3039 IFA$="Y"THEN89
 4000 PRINT"■":END

READY.
```

MEMORY MAPPED SCREEN FOR 3K EXPANSION

This program allows you to control 30720 dots on the screen. To achieve this the screen memory is moved to location 1000 on setting graphics mode. The screen is moved back up to its normal position at 1E00 when graphics mode is cleared.

To use the program type 'SYS 3840' to set the graphics mode, then 'Poke 80,X','Poke 81,Y','Poke 82,C', where X and Y are the coordinates of the dot and C is a command instruction. If C=0, a dot is printed at X,Y. If C=1 a dot is removed, and if C=2 it is inverted. X may be between 0 and 191, and Y between 0 and 159.

Then type 'SYS 3972' to plot, unplot or invert the dot.

You may plot as many dots as you like, but always do it from within a program. If you don't then your VIC will start turning on dots on the left hand side of the screen, making a mess of your masterpiece. When you have finished with the graphics 'SYS 3943' will return you to the normal text mode.

Note that lines 100 to 180 contain a demonstration program, and can be deleted or replaced.

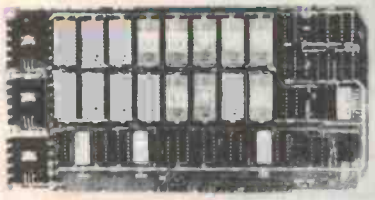
Jan Desmond, Rochedale Qld

```
1 REM PROGRAM TO GIVE A 192*160
  HI-RES SCREEN ON A VIC-20 + 3K RAM

5 REM LOWER TOP OF MEMORY
10 POKE55,255:POKE56,14:CLR
15 REM POKE MACHINE CODE IN PLACE
20 FORT=3840TO4050
30 READA:POKET,A:C=C+A
40 NEXT
50 IFC<>22740THENPRINT"DATA ERROR"
   :END:REM CHECK FOR INCORRECT DATA
100 REM DEMO PROG. DRAWS SINE WAVE
110 SYS3840:REM SET GRAPHICS MODE
120 FORT=0TO191
130 Y=INT( SIN (T * .1) *40)+80
140 POKE80,T:POKE81,Y:POKE82,2:REM
    POKE X,Y,COMMAND
150 SYS3972:REM PLOT DOT
160 NEXT
170 GETA$:IFA$=""THEN170
180 SYS3943:REM CLEAR GRAPHIC MODE
900 REM DATA FOR MACHINE CODE
    HI-RES SUB.
1000 DATA160,0,132,0,169,16,133,1,169,
     0,145,0,200,208,251,230
1010 DATA1,166,1,224,32,208,243,169,8,
     141,15,144,169,16,141,136
1020 DATA2,169,204,141,5,144,169,149,
     141,3,144,169,24,141,2,144
1030 DATA169,16,133,1,160,0,132,0,145,
     0,170,232,165,0,24,105
1040 DATA24,201,240,240,6,133,0,138,
     76,56,15,169,0,133,0,200
1050 DATA192,24,208,243,169,9,141,0,
     144,169,1,160,0,153,0,148
1060 DATA153,0,149,200,208,247,96,169,
     174,141,3,144,169,150,141,2
1070 DATA144,169,30,141,136,2,169,240,
     141,5,144,169,12,141,0,144
1080 DATA32,95,229,96,160,255,165,80,
     56,233,8,200,176,251,105,8
1090 DATA133,87,169,17,133,1,169,0,
     133,0,192,0,240,14,136,24
1100 DATA105,160,176,3,76,152,15,230,
     1,76,152,15,169,128,164,87
1110 DATA240,6,24,74,136,76,176,15,
     164,81,166,82,240,9,224,1
1120 DATA 240,10,81,0,76,208,15,17,0,
     76,208,15,73,255,49,0
1130 DATA145,0,96
```

S100 PRODUCTS

32K S-100 EPROM CARD
PRICE CUT!



$99.00

USES 2716's

Blank PC Board — $69

ASSEMBLED & TESTED
ADD $49.00

KIT FEATURES

1. Uses +5V only 2716 (2K x 8) EPROM's
2. Allows up to 32K of software on line!
3. IEEE S-100 Compatible
4. Addressable as two independent 16K blocks
5. Cromemco extended or Northstar bank select
6. On board wait state circuitry if needed
7. Any or all EPROM locations can be disabled
8. Double sided PC board solder-masked silk-screened
9. Gold plated contact fingers
10. Unselected EPROM's automatically powered down for low power
11. Fully buffered and bypassed
12. Easy and quick to assemble

64K S100 STATIC RAM

$499.00 KIT

NEW!

LOW POWER!

RAM OR EPROM!

BLANK PC BOARD WITH DOCUMENTATION $119.00

SUPPORT ICs + CAPS $29.00

FULL SOCKET SET $19.00

FULLY SUPPORTS THE NEW IEEE 696 S100 STANDARD (AS PROPOSED)

FOR 56K KIT $419

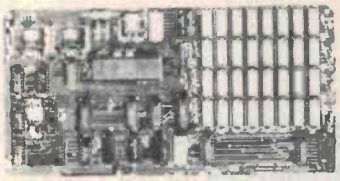
ASSEMBLED AND TESTED ADD $50

FEATURES:

- Uses new 2K x 8 (TMM 2016 or HM 6116) RAMs.
- Fully supports IEEE 696 24 BIT Extended Addressing.
- 64K draws only approximately 500 MA.
- 200 NS RAMs are standard. (TOSHIBA makes TMM 2016s as fast as 100 NS. FOR YOUR HIGH SPEED APPLICATIONS.)
- SUPPORTS PHANTOM (BOTH LOWER 32K AND ENTIRE BOARD).
- 2716 EPROMs may be installed in any of top 48K.
- Any of the top 8K (E000 H AND ABOVE) may be disabled to provide windows to eliminate any possible conflicts with your system monitor, disk controller, etc.
- Perfect for small systems since BOTH RAM and EPROM may co-exist on the same board.
- BOARD may be partially populated as 56K.

256K S-100 SOLID STATE DISK SIMULATOR!

WE CALL THIS BOARD THE "LIGHT-SPEED-100" BECAUSE IT OFFERS AN ASTOUNDING INCREASE IN YOUR COMPUTER'S PERFORMANCE WHEN COMPARED TO A MECHANICAL FLOPPY DISK DRIVE.



FEATURES:

- 256K on board, using + 5V 64K DRAMS.
- Uses new Intel 8203-1 LSI Memory Controller.
- Requires only 4 Dip Switch Selectable I/O Ports.
- Runs on 8080 or Z80 S100 machines.
- Up to 8 LS-100 boards can be run together for 2 Meg. of On Line Solid State Disk Storage.
- Provisions for Battery back-up.
- Software to mate the LS-100 to your CP/M* 2.2 DOS is supplied.
- The LS-100 provides an increase in speed of up to 7 to 10 times on Disk Intensive Software.
- Compare our price! You could pay up to 3 times as much for similar boards.

BLANK PCB (WITH CP/M* 2.2 PATCHES ON DISK) **$99.95**

$699.00

#LS-100 (FULL 256K KIT)

64K SS-50 STATIC RAM

$359.00 (48K KIT)

NEW!

LOW POWER!

RAM OR EPROM!

BLANK PC BOARD WITH DOCUMENTATION $119.00

SUPPORT ICs + CAPS

FULL SOCKET SET

56K Kit $419
64K Kit $499

ASSEMBLED AND TESTED ADD $50

FEATURES:

- Uses new 2K x 8 MK58725P RAMS.
- Fully supports Extended Addressing.
- 64K draws only approximately 500 MA.
- 200 NS RAMs are standard. (TOSHIBA makes TMM 2016s as fast as 100 NS. FOR YOUR HIGH SPEED APPLICATIONS.)
- Board is configured as 3-16K blocks and 8-2K blocks (within any 64K block) for maximum flexibility.
- 2716 EPROMs may be installed anywhere on Board.
- Top 16K may be disabled in 2K blocks to avoid any I/O conflicts.
- One Board supports both RAM and EPROM.
- RAM supports 2MHZ operation at no extra charge!
- Board may be partially populated in 16K increments.

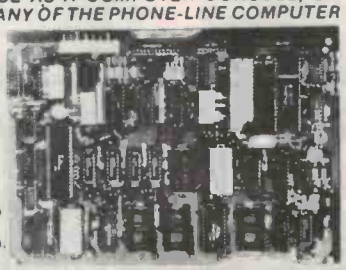
THE NEW ZRT-80

CRT TERMINAL BOARD!

A LOW COST Z-80 BASED SINGLE BOARD THAT ONLY NEEDS AN ASCII KEYBOARD, POWER SUPPLY, AND VIDEO MONITOR TO MAKE A COMPLETE CRT TERMINAL. USE AS A COMPUTER CONSOLE, OR WITH A MODEM FOR USE WITH ANY OF THE PHONE-LINE COMPUTER SERVICES.

FEATURES:

- Uses a Z80A and 6845 CRT Controller for powerful video capabilities.
- RS232 at 16 BAUD Rates from 75 to 19,200.
- 24 x 80 standard format (60 Hz).
- Optional formats from 24 x 80 (50 Hz) to 64 lines x 96 characters (60 Hz).
- Higher density formats require up to 3 additional 2K x 8 6116 RAMS.
- Uses N.S. INS 8250 BAUD Rate Gen. and USART combo IC.
- 3 Terminal Emulation Modes which are Dip Switch selectable. These include the LSI-ADM3A, the Heath H-19, and the Beehive.
- Composite or Split Video.
- Any polarity of video or sync.
- Inverse Video Capability.
- Small Size: 6.5 x 9 inches.



BLANK PCB WITH 2716 CHAR. ROM, 2732 MON. ROM **$99.00**

SOURCE DISKETTE – ADD $20

SET OF 2 CRYSTALS – ADD $12

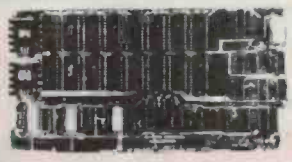
ZRT-80 WITH 8 IN. SOURCE DISK! **$189.00** (COMPLETE KIT, 2K VIDEO RAM)

32K S100 EPROM/STATIC RAM

NEW! FOUR FUNCTION BOARD! **NEW!**

EPROM II FULL EPROM KIT $129

A&T EPROM ADD $35



BLANK PC BOARD WITH DATA $69.00

SUPPORT IC'S PLUS CAPS $29.00

FULL SOCKET SET $25.00

We took our very popular 32K S100 EPROM Card and added additional logic to create a more versatile EPROM/RAM Board.

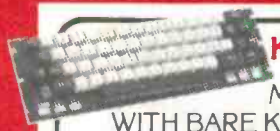
FEATURES:

- This one board can be used in any one of four ways:
  - A. As a 32K 2716 EPROM Board
  - B. As a 32K 2732 EPROM Board (Using Every Other Socket)
  - C. As a mixed 32K 2716 EPROM/2K x 8 RAM Board
  - D. As a 32K Static RAM Board
- Uses New 2K x 8 (TMM2016 or HM6116) RAM's
- Fully Supports IEEE 696 Buss Standard (As Proposed)
- Supports 24 Bit Extended Adressing
- 200 NS (FAST!) RAM'S are standard on the RAM Kit
- Supports both Cromemco and North Star Bank Select
- Supports Phantom
- On Board wait State Generator
- Every 2K Block may be disabled
- Addressed as two separate 16K Blocks on any 64K Boundary
- Perfect for MP/M* Systems
- RAM Kit is very low power (300 MA typical)

32K STATIC RAM KIT — $199.00

For RAM Kit A&T - Add $40

COMPUTER BARGAINS AT MAGRATHS!



KEYBOARDS

METAL FRAME WITH BARE KEYSWITCHES

Full "Qwerty" keys with Backspace, Line Feed, Del, Return, Break, Reset, Shift, ESC, Tab, CTRL, Lock Function Keys.

GREAT VALUE! $29.95

BX 80 DOT MATRIX PRINTER

Printing method:	Serial impact dot matrix.
Printing method:	Alpha-numeric – 7 x 8 in 8 x 9 dot matrix field. Semi-graphic (character graphic) 7 x 8 dot matrix. Bit image graphic – Vertical 8 dots parallel, horizontal 640 dots serial/line.

UNREAL PRICE! $385.00

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NASHUA DISKS

MD1	5¼"	SSSD	$41.66 (10)
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COMPUTER FANS

EP75H	75mm x 38mm THICK	240V	$26.28
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SUPER SPECIAL KEYBOARDS

K-83BCIBM® – APPLE® COMPATIBLE

The keyboard has a permanently attached cable that connects to a 15 PIN connector at the rear of the system unit. This shielded sixteen-wire (or less) cable has power (+5Vdc), ground, RESET, and one STROBE, SEVEN DATA lines. The cable is approximately 6 feet long and is coiled like that of a telephone handset.

The keyboard uses a silicon rubber technology with a microcomputer (Intel 8035) performing the keyboard scan function.

The keyboard has 83 keys arranged in three major groupings. The central portion of the keyboard is a standard typewriter keyboard layout. On the left side are 10 function keys. On the right is a 15-key keypad for functions of numeric entry, cursor control, calculator pad, and screen edit.

$194.81

MITSUBISHI-TEAC DISK DRIVES

MITSUBISHI 5¼" SLIM

M4851	40 TPI	DSDD	$325.00
M4853	80 TPI	DSDD	$350.00
M4854	1.6 MEG.	DSDD	$399.00

MITSUBISHI 8" SLIM

M2896-63	1.6 MEG.	DSDD	$550.00

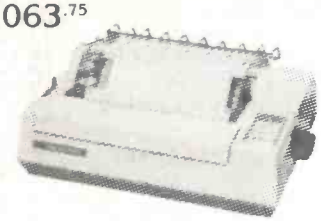
TEAC 5¼" SLIM

PERFORMANCE SPECIFICATIONS	FD-55B	FD-55F
Capacity Unformatted Per Disk	500 Kbytes	1Mbyte
Recording Density	5876 BPI	5922 BPI
Track Density	48TPI	48 or 96 TPI
Number of Cylinders	40	80
Number of Tracks	80	160
Recording Method	FM, MFM	FM, MFM
Rotational Speed	300 RPM	300 RPM
Transfer Rate	250K Bits/sec	250K Bits/sec
Access Time		
Average	93 ms	94 ms
Track to Track	6 ms	3 ms
Setting	15 ms	15 ms
Head Load Time	50 ms	50 ms
Motor Start Time	400 ms	400 ms
	$350.00	$350.00

A whole lot of little drive – TEAC

TEXAS INSTRUMENTS MODEL 850 PRINTER

$1,063.75



Model 850 features:

Printing capabilities.

- 150 characters per second
- Optimized bi-directional printing
- 9 wire printhead – stored energy
- 100 million character printhead life
- 9 x 9 dot matrix standard print
- 15 x 9 enhanced print (at 90 cps)
- True descenders and underlining
- Spacing: characters per inch (cps) and characters per line (cpl)
  - 5 cpi – 50 cpl
  - 8.3 cpi – 66 cpl
  - 10 cpi – 80 cpl
  - 16.7 cpi – 134 cpl
  - Vertical spacing of 3, 4, 6 and 8 lines per inch
- Software-selectable double-strike and emphasis printing
- Subscripts and superscripts

Graphics

- Raster graphics
- Horizontal dot densities of 60, 72, 120 and 144 dots per inch
- Vertical dot densities of 72 and 144 dots per inch
- Eight-bit vertical input
- 64 Mosaic graphics characters

Ribbon

- Snap-in cartridge ribbon
- One-half inch nylon – 10 yards
- Three million character life.

Paper handling

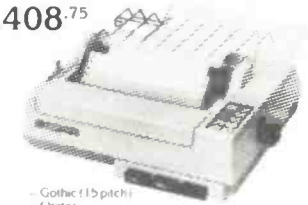
- Standard friction feed
- Maximum 11 inch friction-fed forms width
- Handles single sheet, cut forms and roll paper
- Optional snap-in, out metering tractors
- Maximum 10 inch tractor-fed forms width
- Handles continuous forms (up to three parts)
- In and out top paper path
- Close tear off of one inch from last printed line
- Original plus two copies
- Paper-out switch
- Optional forms tray and paper roll holder.

Interface

- Serial and parallel standard
  - Serial EIA RS 232C subset with 7 or 8 bits, ready busy signal
  - Centronics-type parallel with 1,000 cps, strobe acknowledge

TEXAS INSTRUMENTS MODEL 855 DUAL MODE PRINTER

$1,408.75



Model 855 features:

Printing capabilities.

- 32 x 18 dot matrix double-pass
- 35 cps letter quality mode
- 9 x 9 dot matrix
- 150 cps draft quality mode
- Optimized bi-directional printing
- 9-wire stored energy printhead
- 100 million character printhead life
- Software-selectable bold and shadow print
- Superscripts and subscripts
- True descenders and underlining
- Full ASCII 96 character set

Word Processing Capabilities.

- User-selectable font modules
  - Inserted in front of printer (up to three at any one time)
  - One font style per module provides both draft and letter quality character set
- Font styles available in:
  - Courier
  - Courier Italics
  - Prestige Elite
  - Modern Proportional Space
  - Gothic (10 pitch)
  - Gothic (15 pitch)
  - Orator
- Standard daisy wheel Qume and Diablo and data processing (Epson) compatible escape sequences

Graphics.

- Raster graphics
- Horizontal dot densities of 60, 72, 120 and 144 dpi
- Vertical dot densities of 72 and 144 dpi
- Eight-bit vertical input
- 64 Mosaic graphic character set
- Available in draft and letter quality mode

Ribbon.

- Snap-in ribbon cartridge
- Three million character life

SUPER BARGAINS AT MAGRATHS

SEAL OF SATISFACTION
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GREAT VALUE ON VIDEO MONITORS

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BM-12EA 18MHz	12"	GREEN SCREEN	$195.50
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BOTH WITH BUILT IN SWIVEL TILT BASE

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5¼" (100) FLOPPY DISKETTE STORAGE CABINET

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FUJITSU 8416

$8.04 AT MAGRATHS

- PIN COMPATIBLE WITH HM 6116
- 2048 WORDS BY 8 BITS
- ACCESS TIME 200NS MAX.
- LOW POWER: 55µW MAX. STANDBY
- SINGLE +5V POWER SUPPLY +10% TOL.
- TTL COMPATIBLE INPUTS/ OUTPUTS
- LOW VOLTAGE DATA RETENTION 2.0V MIN

MAGRATHS PRODUCT OF THE MONTH!

All-In probe. New features give it high mobility.
Auto Range Selection Probe-Type DMT (Accompanied by Soft Case) PD-470C.

- Auto range selection-type functions.
- Results of measurement can be read directly on the unit.
- Up to 2MΩ of resistance can be measured, and with low power at that.
- DC power consumption is only 3mW.
- Exhaustion of battery is indicated by BATT mark lighting up.
- All operations can be conducted with one hand.
- In places where the display cannot be looked at during measurement, the indication holding function comes in handy. The measured value can be held by a push on the lock switch.
- The unit provides multiple measuring functions: (1) AC and DC voltages of which up to 500V can be measured; (2) resistances of up to 2MΩ; and (3) continuity check.
- The resistance measuring department constitutes a low power ohmmeter with the applied voltage held below 0.45V. It can measure semi-conductor circuits in an in-circuit condition.
- All voltage and resistance ranges are automatically selected. The operator need not change or select ranges as the unit measures and indicates in the auto-selected optimum range.
- For power source, two LR-44 or SR-44 (G-13) button cells are used.
- Such switch outout is adopted as to ensure highest ease of operation. All switches including power, function changeover, AC/DC changeover and data hold switches can be operated with one hand that holds the probe.

SPECIALS ON INTERFERENCE SUPPRESSION CAPACITORS

RIFA PME271 SERIES

.01 µFD to .047 µFD	250V AC	.76 each
.1 µFD to .33 µFD	250V AC	$1.54 each

NEW

YF-208 MULTIMETER WITH BUILT-IN LOGIC PROBE!

$28.75

FEATURES:

- Logic testing function, speeds to test "HIGH", "LOW", "PULSE". Also convenient for trouble shooting and logic circuit test.
- Self shielded meter movement, avoids interruption of external magnetic field to increse measuring accuracy.
- Diode and fuse protection, prevents both meter movement and circuit from damages.
- Solid construction, with poly-carbonet switch and elastic contactor to ensure durability and reliability.
- Provides maximum measuring range. The voltage is up to 1200V and resistance to 10MΩ.

SPECIFICATIONS:
11 Function and ranges

Function	Measurement ranges	Allowance	Remarks
DC Voltage	0-0.3, 3, 12, 60, 300, 1200V	Within ±3% f.s.	Input Impedance 4KΩ/V
AC Voltage	0-6, 30, 120, 300, 1200V	Within ±4% f.s.	Input Impedance 4KΩ/V
DC Current	0-0.06, 3, 30, 300mA	Within ±3% f.s.	Voltage drop 300mV
Resistance	Range x 1, x 10, x 1K, x10K Max 500, 5K, 1M, 10MΩ Midscale: 30, 300, 10K, 100K Ω Min. 1, 10, 200, 2KΩ	Within ±3% of scale length	x1, x10, x1K Voltage 1.5V x10K Voltage 9V
Decibel	—10dB ——— +17dB ——— +63dB	Within ±4% f.s.	
Logic test	Test voltage 5V Max Core voltage 1.5V ±0.3 Max High voltage 3.0V ±0.3 Min. Test Pulse Frequency 3.3MHz ±0.3Hz Max		

SUPER BARGAINS AT MAGRATHS

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MAGRATHS
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PHILIPS TRIMMER CAPACITORS

2pF-10pF	56 each	5.5pF-40pF	56 each
2pF-27pF	56 each	5.5pF-60pF	56 each

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$2.35 EACH

☆ FOR CONTACT PROTECTION
☆ TRANSIENT SUPPRESSION FOR TRIACS, THYRISTORS
RIFA PMR 2026 SERIES 630V DC
.25 µFD + 22 OHM, 68 OHM, 220 OHM, 470 OHM
.5 µFD + 22 OHM, 220 OHM

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AA119 AM FM DETECTOR	38¢
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2516	16K EPROM	$4.27
2532	32K EPROM	$8.05
MB8118	16K x 1 RAM	$4.54
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76488	SOUND SYNTHESIS	$4.23
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COPY PROGRAMS

Michael Alexander, Balaclava Vic.

The following short program is for all those Microbee owners who wish to make backup copies of their bought tapes *for personal use*. The easiest way to copy a tape is to simply take two tape recorders and connect them together. This approach is OK, except that reliability may suffer because of the signal shaping circuitry in modern recorders which is not designed to handle square waves efficiently. My approach still uses two recorders but the signal is sent via the computer to square it up before recording. It is written in BASIC for ease of use, but the program only serves to enter a machine language subroutine.

To use it first play the tape into the computer to check that it will load, and time how long it takes. Then get rid of the programME and enter the one shown below. Type RUN and connect the lead which usually goes to the earphone output of the cassette player from which you are playing the tape. The other wire goes to the microphone input of the other recorder. Play the tape back into the computer and simultaneously record it with the other recorder. Having timed it before, you should know how long it takes. Leave an extra few seconds after it just to be on the safe side. Play back your new tape into the computer using Load, to test it. The copy is of a slightly worse quality than the original, so always use the backup and put the original away in a safe place. If the backup fails, just make another copy from the original.

```
10 FOR R=0 TO 6:READ A:POKE R,A: NEXT R:A=USR(0)
20 DATA 219,2,23,211,2,24,249
```

4 MHZ MODIFICATION

F. Capmeil, Paddington, NSW

If you have an early Microbee, with a 2 MHz clock, this modification will be of interest.

The 2 MHz is obtained from a 12 MHz oscillator that is divided in six by a 7492, IC32 on the main board. I have found that the same IC is doing a divide by −4 (4 MHz). I have also found that the Z80 on the Microbee runs very well on 4 MHz. In no time at all I had a little switch installed to change over from two to four MHz.

Of course everything runs twice as fast and I can record at 600 Bd and 2400 Bd. My tape recorder (a Sony TCM747) makes a few mistakes at 2400; for safe data 600 is ideal, for program loading 1200 is quite OK.

This is how to perform the modification: if your ICs are soldered, cut IC32 pin 8 and solder a wire on it. Take this wire to the normally closed contact of a mini toggle switch (use a double pole to have room for a LED to indicate status). Solder another wire from pin 9 of the IC and connect it to the normally open contact of your switch. The last step is to solder a wire, where the pin that we cut off was connected, on the board (this is easier if it is done under the board). This wire goes to the common of the switch.

To avoid glitches a 'wait' key is necessary. It can just be a temporary push button but I chose to fit an extra key purchased from A. T. with the letter 'W' on it. It fitted under shift and reset where there is a cut-out on the keyboard frame). One contact of the push-button goes to ground. The other one to pin 24 of the Z80 (wait pin).

To change over from 2 MHz to 4 MHz just push 'wait' and change over. This wait key is very useful for debugging etc.

LARGE DISPLAY

H. Beilharz, Kareela NSW

This is a bit of a novelty program that was developed to help my four year old son learn the alphabet. The program actually contains two parts selected from a menu (lines 120 to 200).

Part 1 of the program (lines 280 to 510) gives a display of 12 characters by three lines. This is done by reading the character generator and setting a LORES dot for each character dot. The program operation is as follows:

Select option A from menu, the screen will then go blank ready for you to start inputting letters, (note return is not required).

The control keys are:

Tab to return to menu

Linefeed to go to beginning of next line

Delete to delete last entry

The screen does not scroll so when the end of the third line is reached the screen will clear and start again.

Part 2 of the program (lines 530 to 750) displays one letter the full height of the screen. This is done by setting two inverse character blocks for each character dot. The program operation is as follows:

Select option B from menu. The screen will now display a large question mark. Type any letter to see it full size.

The control keys are:

Tab to return to menu

Backspace to give inverse characters

Linefeed to give normal characters

Both programs will display the full character set including control characters, but do not press control C as this will stop the program.

```
00100 REM "LARGE DISPLAY   HANS BEILHARZ "
00110 SPEED0:DIM L1(8),L2(16)
00120 CLS:PRINT "          select option by letter"\
00130 PRINT " A     large letters"
00140 PRINT " B     very large letters"
00150 PRINT " C     end"
00160 GOSUB 220
00170 M=N-64
00180 ON M GOTO 280,530,200
00190 GOTO 160
00200 SPEED 50:END
00210 REM "read keyboard"
00220 POKE 257,1
00230 X1$=" "
00240 X1$=KEY$
00250 N=ASC(X1$)
00260 RETURN
00270 REM
00280 REM"Large letters"
00290 DATA 128,64,32,16,8,4,2,1
00300 RESTORE 290:FOR J=1 TO 8:READ L1(J):NEXT J
00310 LORES
00320 CLS:X=0:Y=48
00330 GOSUB 230
00340 IF N=8 THEN 320
00350 IF N=9 THEN 120
00360 IF N=10:X=0:Y=Y-16:N=128:IFY<15THEN320
00370 IF N=128 THEN 330
00380 IF N=127:IF X>0:X=X-10:GOTO480
00390 M=16*N+61440
00400 FOR I=1 TO 16
00410 IN#0 OFF:OUT 11,1:Q=PEEK(M+I-1):OUT 11,0:IN#0 ON
00420 FOR J= 1 TO 8
00430 IF Q>=INT(L1(J)):Q=Q-INT(L1(J)):SET X+J,Y-I
00440 NEXT J:NEXT I:X=X+10
00450 IF X>110:X=0:Y=Y-16
00460 IF Y<16 THEN 320
00470 GOTO 330
00480 FOR I=1 TO 16:FOR J=1 TO 8
00490 RESET X+J,Y-I
00500 NEXT J:NEXT I
00510 GOTO 450
00520 REM
00530 REM "Very large letters"
00550 RESTORE 290:FOR J=1 TO 8:READ L1(J):NEXT J
00560 Y=0:INVERSE:NORMAL
00570 FOR A=0TO16:POKE 63488+A,255:NEXT A
00580 N=63:GOTO640
00590 GOSUB 230
00600 IF N=9 THEN 120
00610 IF N=8 :Y=1:N=63
00620 IF N=10 :Y=0:N=63
00630 IF N=128 THEN 590
00640 CLS
00650 K=61460:M=16*N+63488
00660 POKE 62399,N
00670 FOR J=0 TO 15
00680 I=PEEK(M+J):IFY=0:I=255-I
00690 FOR Q=1 TO 8
00700 IF I>=INT(L1(Q)): I=I-INT(L1(Q)):POKE K+2*Q,128:POKE K+1+2*Q,128
00710 NEXT Q
00720 IFY=1:POKE K+18,128:POKE K+19,128
00730 K=K+64
00740 NEXTJ
00750 GOTO590
```

MUSICAL NOTE FREQUENCIES

Tom Moffat, Fern Tree Tas.

Have you ever suspected that your piano is out of tune? Or are you building a synthesizer, and want to tune it. Or are you just curious? The program listed below will tell you the frequency of any music tone to within several decimal places. Admittedly it's probably 'overkill' but the program is fun to play with (not another pun . . .) and maybe even educational. Although it's written for the MicroBee, that computer's particular tricks have been avoided. So the program should run on any computer with few modifications.

The program asks for two inputs. First, the musical note in question, expressed in standard notation (C#, Ab, B). You must then specify what octave the note lies in. 0 is the octave containing middle C. −1 is the octave below it, −2 is two below, 1 is the octave above the one with middle C, and so on. After a short delay the program reveals the note's frequency. The program as shown works on the standard piano tuner's scale, based on perfect fifths and stretched octaves. In this scale a note an octave higher isn't twice the frequency, it's twice plus a bit. Each semitone is the seventh root of 1.5 times the note before it.

The program can be changed to work on the 'perfect' musical scale in which each octave is exactly double the previous octave. In the 'perfect' scale each semitone is the twelvth root of two above the note before it.

The perfect scale was used by European musicians until the 17th century when the advent of pianos and the tendency of composers to change key forced a more complex method of tuning.

To see how things were then, change line 230 to read 'F1=440*(2 (1/12)) B1'. In either case the calculations start from the International standard 'A' of 440 Hz.

The mathematics in the program is capable of producing some interesting results for those with fertile minds. Consider, for instance, a piano with a keyboard 50 octaves wide. The lowest note, the 'A' 25 octaves below middle C, would produce one audio cycle in 22.226 hours, just under a day. The highest note, 'E' 25 octaves above middle C, would have a frequency of 11.595 GHz, well into the microwave band. The piano would be 8 meters wide, so to play it you'd need to have the arms of King Kong, or be able to run pretty fast.

Cracking a problem. Tom Moffat demonstrating his subtle fault-finding techniques on the Microbee.

```
00100 REM MUSICAL NOTE FREQUENCIES
00110 REM Tom Moffat
00120 REM
00130 DIM N1(2,17)
00140 FOR I=1 TO 17
00150 READ N1(1,I),N1$(2,I)
00160 NEXT I
00170 INPUT "ENTER A NOTE ( C#, Ab, etc.)";A1$
00180 INPUT "WHAT OCTAVE ( -1, 0, 1, etc.)";B1: B1=B1*12
00190 F=0: FOR I=1 TO 17
00200 IF A1$=N1$(2,I) THEN LET B1=B1+N1(1,I): F=1
00210 NEXT I
00220 IF F=0 THEN PRINT "  >>> IMPOSSIBLE NOTE!": GOTO 170
00230 F1=440*(1.5^(1/7))^B1
00240 PRINT: PRINT "  ** NOTE FREQUENCY IS";F1;" Hz."
00250 PRINT: PRINT: GOTO 170
00260 DATA -9,"C",-8,"C#",-8,"Db",-7,"D",-6,"D#",-6,"Eb"
00270 DATA -5,"E",-4,"F",-3,"F#",-3,"Gb",-2,"G",-1,"G#"
00280 DATA -1,"Ab",0,"A",1,"A#",1,"Bb",2,"B"
```

3D GRAPH GENERATOR

M. Kostecki, Elizabeth Park SA

This program demonstrates the excellent graphics capabilities of the Microbee. Plots of three dimensional surfaces are shown in high resolution graphics (HIRES). These look like those computer shapes with grids that you may have seen before.

The equation of the surface is changed in line 160 using the EDIT mode. To start with, here's some interesting equations;

```
Z1=SQR(ABS(X1*Y1/28))*2-Y1/16
Z1=FLT(INT(Y1)/4+INT(10-X1)/4)
Z1=X1*X1/32+SIN(Y1/2)*2
Z1=COS(X1*Y1/8)/2.4-Y1/14
Z1=X1/4-Y1*Y1/28-X1*X1*X1/200-Y1/4
Z1=EXP(-ABS(X1/3)-ABS(Y1/3))*10
```

The number which changes rapidly in the top left corner is the number of PCG characters used and so must be kept below 128 or the program will freeze before the surface is finished. Try changing numbers in the above equations to see what differences they cause.

```
00100 REM ### 3D Graph Generator ###
00110 REM # Miroslav Kostecki #
00120 DIM T(20,20,2) : SD4: HIRES
00130 ON ERROR GOTO 270: REM #Stop on error
00140 FOR X=0 TO 20: FOR Y=0 TO 20:REM #Y
      slices
00150 X1=FLT(X-10): Y1=FLT(Y-10)
00160 Z1=ABS(X1)/4+ABS(Y1)/4: REM #Equation
00170 A=INT(X1+X1+Y1)*4+256:U=INT
      (Z1*8+Y1*4)+ 128
00180 IF Y=0 THEN 200
00190 PLOT B,C TO A,U: CURSO: PRINT [14
      USED];
00200 B=A: C=U: T(X, Y, 1)=A: T(X, Y, 2)=U
00210 NEXT Y: NEXT X
00220 FOR Y=0 TO 20: FOX X=0 TO#20:REM
      #X slices
00230 A=T(X, Y, 1): U=T(X, Y, 2): REM #Stored
      points
00240 IF X=0 THEN 260
00250 PLOT B,C TO A, U: CURSO: PRINT [14
      USED];
00260 B=A: C=U: NEXT X: NEXT Y
00270 GOTO 270: REM #Wait a long time.
```

Now you can write your own equations using the above equations as examples. A good, clear result can be obtained by experimenting with your own equations to change the depth of angle.

To keep the program short and simple, lines behind a surface are not removed. You may like to add this yourself to improve clarity.

32K UPGRADE

J. Richards, Jamboree Heights Qld.

MicroBee owners who attempt Tom Moffat's suggestion for upgrading their machines from 16K to 32K (ETI May 1983, p96) should be aware of a problem they will encounter as a result of not having the revised BASIC ROM set supplied by Applied Technology.

The memory test routine as listed will leave the last byte of memory complemented if RAM is found to extend to address 7FFFH. Routines that store data extending from the top of RAM downwards will find this data corrupted on each reset or self-test.

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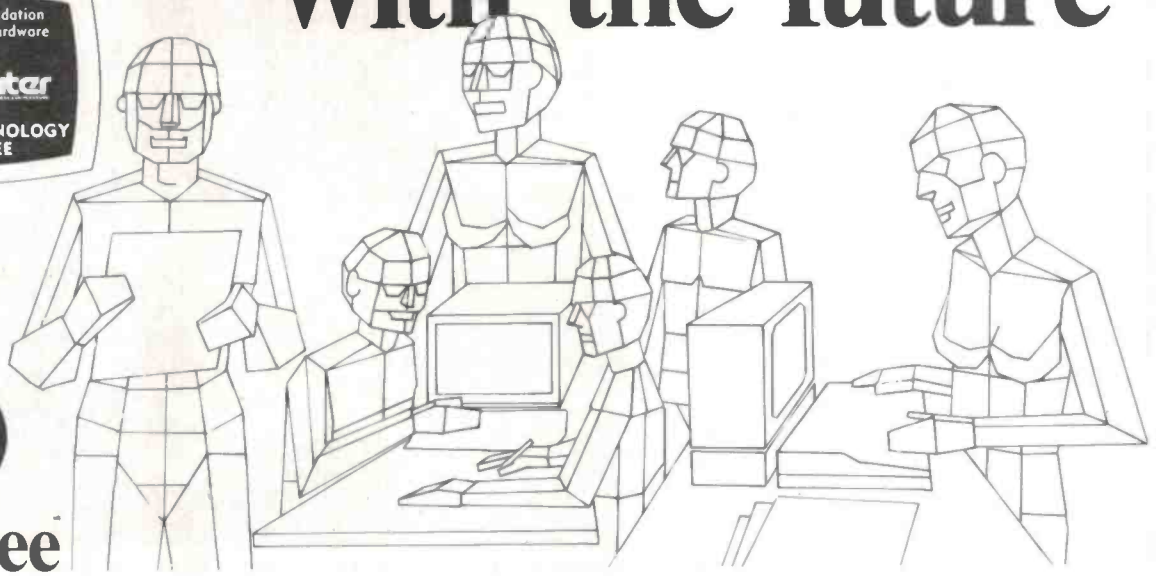

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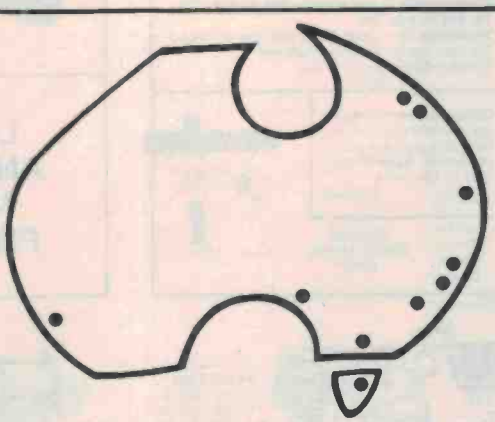

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The 4300b has been specifically designed to facilitate measurement of large inductive loads, such as large power transformers. Its test current can be as high as 10 A on some ranges.

The makers claim that because of this high current rating it is ideal for all kinds of measurement where low resistance or high inductance may be found.

An unusual feature of the 4300b is that it has an 'automatic temperature compensation' network that automatically corrects the readings to indicate the actual temperature of the sample at a predetermined base point.

More information is available from **Paton Electronics, 90 Victoria St, Ashfield NSW 2131. (02)797-9222.**

Dynamic signal analyser

Hewlett-Packard's dynamic-signal analyser, the HP 3561A, is claimed to have a high performance and measurement versatility for real-time spectrum analysis with additional capabilities for network measurements and waveform recording.

The HP 3561A provides an 80 dB dynamic range over a 100 kHz frequency range with an amplitude accuracy of ±0.15 dB.

Flexible 'zoom' analysis gives a resolution of 0.000640 Hz. Typical real-time measurement rates are 7.5 kHz in the fast display mode and 3 kHz in the normal display mode.

A band-limited, band-translated noise source built into the HP 3561A, combined with trace math, enables the instrument to make amplitude or phase network measurements.

Network analysis measurements include characterising frequency response of analogue, crystal or switched-capacitance filters, baseband amplifiers, switching power supplies, modems and weighting filters.

A 13-bit, 256 kHz analogue-to-digital converter and a 40K sample time buffer allow users to capture and analyze events containing up to 100 kHz frequencies with 80 dB of alias protection.

The HP 3561A can be used for vibration and acoustic analysis, interpreting vibrations in the areas of dynamic balancing, run-up or coast-down and acoustic-noise emission.

For more information contact **Hewlett-Packard Australia Ltd, 31-41 Joseph St, Blackburn Vic. 3130. (03)895-2895.**

New digital storage CRO

A new digital storage oscilloscope featuring an extremely high sampling rate has been announced by Gould Inc. Design and Test Systems Division.

Designated the 4030, this digital storage oscilloscope brings the benefits of digital storage techniques to new application areas such as the testing of microprocessor-based systems and video equipment.

The 4030 features a 20 MHz real-time digitising rate which allows the capture of medium to high frequency input. This feature permits its use in a wide variety of applictions, from power supplies to telecommunications.

At the touch of a button the 4030 can become a real-time oscilloscope, able to display repetitive signals. This proves an asset to engineers who need to view minor fluctuations such as amplitude modulations in a stable frequency.

Dual channel simultaneous recording ensures there is no loss of time resolution when studying two operations. Individual channel hold allows a reference signal to be stored and compared against what is being concurrently recorded on the other channel.

The ability to designate 'master' and 'slave' roles offers further flexibility. Individual 4030s can be programmed to operate at the same clock times as the 'master', enabling simultaneous operation as each machine looks at a different aspect of the same system.

In addition, the 4030 includes 8-bit vertical resolution, 1K memory per channel giving high resolution in both X and Y direction and an analogue plotter output.

For further information contact **Elmeasco, P.O. Box 30, Concord NSW 2137. (02)736-2888.**

Aaron DMMs

Neotronics, who handle the Aaron range of DMMs, has announced three new models.

The units are styles MM220, MM230 and MM210. All feature auto and manual range control, audio continuity and diode test facilities.

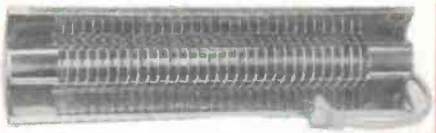
The difference between them is accuracy, and of course, price. The MM220 is accurate to 0.05%, the MM230 to 0.25% and the cheap ($59) MM210 comes in at 0.75%.

Neotronics also handles Neuberger digital panel meters. For a catalogue of specifications and prices write to **Neotronics** at **P.O. Box 289, Newport NSW 2106. (02)918-8220.**

ROD IRVING ELECTRONICS

425 HIGH ST, NORTHCOTE 3070 VIC PHONE (03) 489 8866

THIS MONTH'S KITS



ETI-275 BATHROOM STRIP HEATER TIME-OUT

Ever left your bathroom strip heater on all day? Sure boost the electricity bill! This simple project automatically turns off the heater after allowing you enough time for morning ablutions. Just pull the switch cord when you walk in the bathroom of a morning and the project does the rest.

ETI-1523 ELECTRONIC SCALES

In response to reader demand, we've devised a digital readout electronic scales project. Using a unique technique of having a printed circuit strain gauge bridge **printed on the board,** this project avoids the necessity of using difficult to get strain gauge sensors as well as the necessity of their set-up and calibration.

ETI-669 PANGALACTIC EPROM ERASER

If you walk into the restaurant at the end of the universe and tell the bartender you're confused, he'll say "don't panic!, have a pangalactic gargleblaster. It will erase your current existence allowing The Master to reprogram you for another time and space". Well, our little EPROM eraser does a similar job for your 2716s, 2732s, 2764s ... et al. Parts list attached.

Led Head Lightchaser

(Battery and headband extra)

$12

PLUG PACK REGULATOR

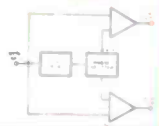
$14

Plugpack Extra

$55.00

STEREO SYNTHESISER FOR TUNERS AND VCRs

Enjoy the benefits of stereo sound from your video cassette recorder, TV or AM tuner with this Stereo Synthesiser. The circuit uses just four ICs and is easy to build.



REMOTE INFRARED TV SOUND CONTROL

$40

E.A. JANUARY "83".

Designed to relieve the long-suffering TV viewer from painful, brain-killing advertisements, our TV Sound Control provides remote control of volume. It gives eight steps of control, including full off, when total silence is called for. Give yourself a break and relieve advertisingl tedium today.

PH METER

$135

with probes

12/240 volt Inverter 40 WATTS

$49.50

EA ELECTRONIC STARTER FOR FLUORESCENT LAMPS

$4.95

EA POWER UP

$38.50

EA NOV 1982

BOGGLE GOGGLES

$9.60

Short form

OVER 200 NOW SOLD

EA INVERTER INCLUDING TRANSFORMER 300 WATTS

$195

P & P $10.00 Anywhere In Australia

JUNE EA 1982

SPECIFICATIONS FOR 300W INVERTER

Nominal Supply Voltage	12V DC
Output voltage	see table
Frequency	50Hz ± .005%
Regulation	see table
Maximum Load	300VA
Current Limiting	30A (primary)
Efficiency	see table

Resistive load W	Output voltage (RMS)	Input current (A)	Efficiency (%)	Battery life 40Ah/20h rate (minutes)
no load	210	1.2	0	—
40	235	4.5	60	240
100	240	11.3	62	80
140	240	15.0	69	60
200	240	20.1	78	50
240	240	24.0	79	32
300	235	29.6	82	28

EA DIGITAL READOUT FOR SW RECIEVERS

$72.00 COMPLETE

OCTOBER EA 1982

Want to add digital frequency readout to an AM radio or shortwave communications receiver that uses an old-fashioned analog dial? This unit features a bright four-digit LED display, 1kHz resolution, and a 0.2s update time that's fast enough to follow the tuning knob.

SPECIFICATIONS

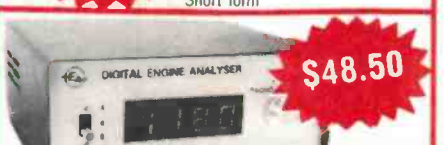
Ranges (full scale): 0-10MHz and 10-30MHz (optional).

Display: Four digit

Resolution: 1kHz with division switch set to divide by one; 10kHz with division switch set to divide by 10.

Sensitivity: Less than 100mV from 500kHz to 30MHz.

Offset frequency: Prototype set to 455kHz, but any offset frequency can be programmed.



$48.50

Engine Analyser Kit

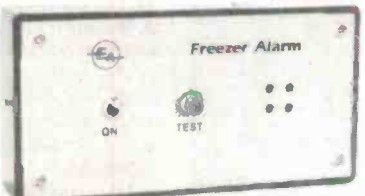
$189.00

Analogue and Digital Storage CRO Kit

EA EASY-TO-BUILD FREEZER ALARM

$21

OCTOBER EA 1982

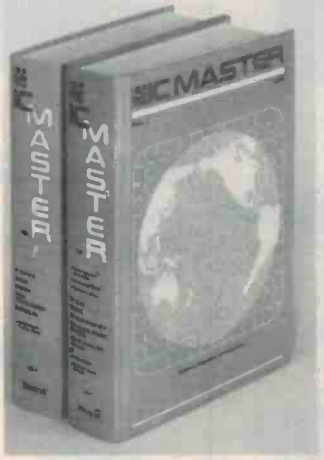


48-50 A'BECKETT ST, MELBOURNE 3000 VIC **PHONE (03) 347 9251**

Mail Order Delivery Instructions: Minimum Pack and Post $3.00 for Australia Post. Please allow extra for bigger orders and Certified, Airmail or Registered Post. Minimum order is $5.00. Please address orders to Mail Order Department, PO BOX 235, NORTHCOTE, 3070, VICTORIA. PHONE (03) 481 1436.

Semiconductor source book

The 1984 International edition of 'IC Master' has been published by Hearst Business Communications. The new edition lists key specifications for more than 38 000 integrated circuits, microcomputer boards, microprocessor development systems, PROM programmers, and custom/semicustom integrated circuits made by 220 manufacturers.



Only products currently available worldwide are described in the product data tables. Both new and discontinued devices, however, are shown in an alternate-source directory which provides information on replacements, and lists approximately 60 000 IC substitutions.

The two-volume set contains more than 3300 pages, and weighs 4.1 kilograms (approximately 9 pounds). Divided into 20 sections (such as microprocessors, memories, linear integrated circuits, custom/semicustom ICs, etc), each product group is organised by key specifications. For example, all 64K dynamic memories are grouped together by organisation, and then arranged in order of speed.

As an example of the use of IC Master, suppose an engineer needs a CMOS single-pole, single-throw analogue switch with a driver. All of these devices are grouped together, first arranged by increasing 'on' resistance, and then by increasing signal range and supply voltage. Although the IC with the exact specifications may not exist, he will be directed to the one that is closest to his needs.

More than 70 IC manufacturers, including Advanced Micro Devices, American Microsystems Inc, Fairchild, Harris, Intel, Motorola, National Semiconductor, Plessey, RCA, Signetics, Texas Instruments, and Zilog have supplemented the editorial material and tables in IC Master with extensive datasheet sections.

The eleven technical data sections in IC Master, organised by function and key parameters, are Military, Digital, Interface, Linear, Memory, Microprocessor, Microprocessor Development Systems, Microcomputer Boards, Microcomputer Support Boards, Custom/Semicustom ICs, and PROM Programmers.

The eight supporting sections are the Advertiser's Product Index, Part Number Index, Part Number Guide (in this section, each company's part numbering system is explained), Guide to Logos, Application Note Directory, Alternate Source Directory, Manufacturers' and Distributors' Directory, and Function Index (in this section, all functions found in IC Master are arranged in alphabetical order).

The Australian distributor is **A. J. Distributors, P.O. Box 71, Prospect SA 5082. (08)269-1244.**

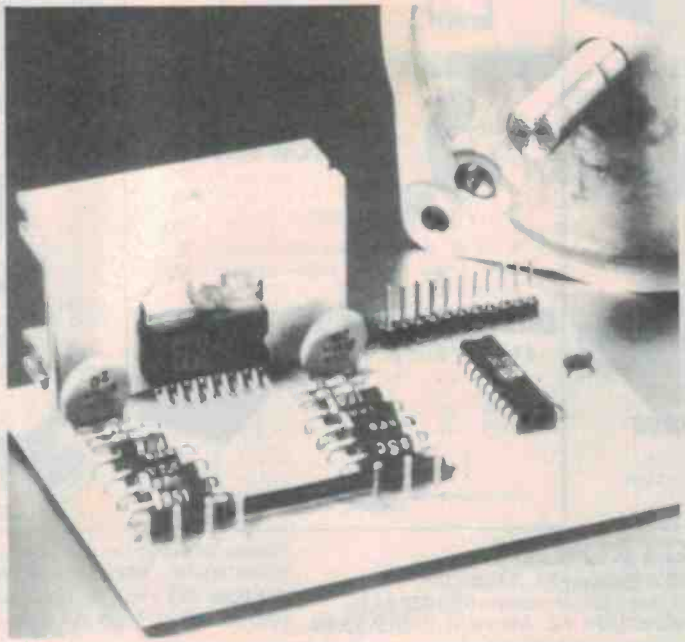
Stepper motor controller

The Italian SGS company has just released its stepper motor controller onto the Australian market through the local distributor, Ellistronics.

The controller comes as two chips, the L297 controller and the L298 driver. Between the two of them they form a complete micro-to-motor interface.

The L298 driver can deliver up to 200 W to the motor. Where this is not necessary a smaller version, the L293E may be used. This has a 36 W output.

For information contact **Ellistronics, 797 Springvale Rd, Mulgrave Vic. 3170. (03)561-5844.**



'NIF'ty IC socket

The Adelaide distributor, Mayer Kreig, has begun distribution of the world's first no insertion force (NIF) IC socket.

The IC is clamped into the socket by a small locking tab on the side of the socket. The IC can be easily removed by releasing the lock.

Mayer Kreig advise insertion and locking tools will be available shortly.

Contact **Mayer Kreig and Co at G.P.O. Box 1803, Adelaide SA 5001. (08)223-6766.**

MOSFETs of the third kind

Siemens has developed a new, third generation device, the BUZ 211, which moves a step closer to overcoming the usually slow recovery time of the inverse diode connecting the drain and source.

With the introduction of Siemens' 300 ns fast-recovery epitaxial diode (FRED), the slow reverse recovery time of the diode — a problem inherent in all power MOSFETs — has been slashed fivefold compared to average devices.

The new family of power MOSFETs eliminates the addition of external freewheeling diodes or other protection circuits for PWM motor control applications, in which the transistors are connected in bridge style configurations.

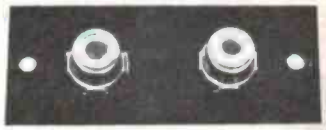
The first transistor in this series, the BUZ 211, features a 500 V rating with a continuous drain current of 9 A (27 A peak). It is packaged in a T0-3 housing, capable of dissipating 125 W.

For more information contact **Promark Electronics, 366 Whitehorse Rd, Nunawading Vic. 3131. (03)878-1255.**

PRE-STOCKTAKE SALE

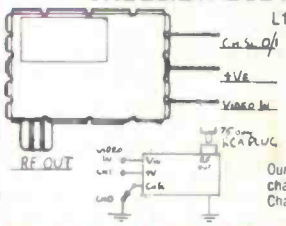
ENDS 15TH JULY 1984

PANEL MOUNTING RCA SOCKETS



		1-9	10+
P10232	2 way	.35	.30
P10234	4 way	.45	.40
P10236	6 way	.60	.50

VIDEO RF MODULATOR
UNBELIEVABLE PRICE



1-9	10+
$4.95	$3.95

Our RF Modulators are channel selectable either Channel 0 or Channel 1

DELUXE METAL CABINETS
A "STEEL" AT THESE PRICES

		1-9	10+
H10442	150x61x103mm	3.95	2.95
H10444	184x70x160mm	4.95	3.95

CANNON TYPE CONNECTORS
DIRECT IMPORT PRICE

		1-9	10+
P10960	3 PIN LINE MALE	1.90	1.60
P10960	3 PIN CHASSIS MALE	1.90	1.60
P10964	3 PIN LINE FEMALE	2.50	2.10
P10966	3 PIN CHASSIS FEMALE	2.90	2.20

¼ WATT 5% RESISTORS E24 VALVES
CARBON FILM

$1.00 per hundred
$7.50 per thousand

That is 0.75 of a cent each
But Must Be The Same Value

34 WAY EDGE CONNECTORS FOR DISK DRIVES
SCOOP DIRECT IMPORT PURCHASE

1-9	10+
$5.95	$4.95

Errors & omissions excepted.

HIGH CLASS INSTRUMENT KNOBS

Half price this month

H10060	35mm	.50
H10061	24mm	.45
H10062	20mm	.40
H10063	15mm	.38

KEY SWITCHES

1-9	10+
$3.95	$3.75

MINIATURE PCB RELAYS

Massive 3A contacts at 24VDC or 100VAC Nominal 12V Coil but will work OK from 9-15V.

SPECIFICATIONS	S.P.D.T. S14060	D.P.D.T. S14061
Nominal Coil Voltage	12V	12V
Contact Current (max)	3A	3A
Contact Voltage (max)	125VAC	60VAC
Coil Resistance	400 ohm	300 ohm
PRICE		
1-9	$1.20	$1.50
10-24	$1.00	$1.20
25-99	$0.80	$1.00

ECONOMY TOGGLE SWITCHES

		1-9	10+
S11010	SPDT	1.00	.70
S11020	DPDT	1.20	.80

HORN SPEAKER

WOW $6.95

C12010

5" A. B. S. Material Horn Speaker 8 ohm. Freq. Range: 600—5000Hz Max Power: 8 W

BRIDGES & DIODES

6A 400V Bridge $1.50

	1-9	10+	100+
IN5404	.20	.18	.14
IN5408	.25	.20	.15

DISCOUNTED PANEL METERS
BUT BE QUICK FOR THESE

PANEL METERS		NORMALLY	THIS MONTH	
Q10500	MU45	0-1mA	9.75	6.95
Q10502	MU45	50-0-50uA	9.75	6.95
Q10504	MU45	0-100uA	9.75	6.95
Q10505	MU45	0-50uA	9.75	6.95
Q10518	MU45	0-1A	9.75	6.95
Q10510	MU45	0-5A	9.75	6.95
Q10515	MU45	0-10A	9.75	6.95
Q10520	MU45	0-20V	9.75	6.95
Q10525	MU45	0-30V	9.75	6.95
Q10535	MU45	VU	10.95	8.95
Q10530	MU52E	0-1mA	10.95	7.95
Q10533	MU52E	0-5A	10.95	7.95
Q10538	MU65	0-50uA	13.95	7.95
Q10540	MU65	0-1mA	13.95	7.95
Q10550	MU65	0-100uA	13.95	7.95
Q10560	MU65	0-20V	13.95	7.95

IC SOCKETS (LOW PROFILE)
HOW CHEAP CAN THEY GO

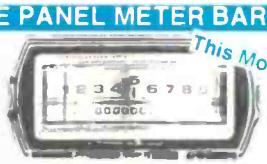
	1-9	10-99	100-999	1000+
8 Pin	.15	.14	.12	.9
14 Pin	.16	.15	.14	.10
16 Pin	.17	.16	.15	.11
18 Pin	.18	.17	.16	.13
20 Pin	.29	.28	.27	.26
24 Pin	.35	.33	.32	.28
40 Pin	.45	.40	.35	.30

5 WATT RESISTORS
WE ARE OVERSTOCKED YOU REAP THE SAVINGS

1-9	10-99	100+
.25	.22	.20

½ PRICE

MORE PANEL METER BARGAINS



This Month $2.95

Normally

1-9	10+
4.50	3.95

Q10400
250 ua Sensitivity Panel cut-out 36mm x 16mm. Mounting hole centres at 49mm.

This Month $2.95

Normally

1-9	10+
4.95	4.50

Q10405
250 ua Sensitivity centre 'O' very useful for balanced circuit and applications needing a centre 'O' or null indication.

2¼" Speaker Only $1.00

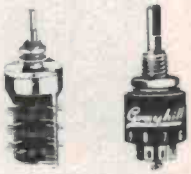
welcome here

ROD IRVING ELECTRONICS

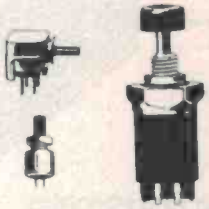
425 High St., Northcote, Vic. 48-50 A'Beckett St., Melb., Vic.
Phone (03) 489 8866, (03) 489 8131, Mail Order Hotline (03) 481 1436
Mail orders to P.O. Box 235 Northcote 3070 Vic. Minimum P & P $3.00.

Please address tax exempt, school, wholesale, and dealer enquiries to: **RITRONICS WHOLESALE**
1st floor 425 High St. Northcote 3070 (03) 489 7099
(03) 481 1923 Telex AA 38897

Grayhill means switches...and much more

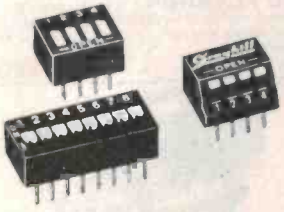


Rotary Switches
Single deck, space saving. Multi-deck, 1 to 12 poles per deck—2 to 24 positions per pole—1 to 12 decks. Military and commercial types. Keylocks, momentary and isolated positions.



Pushbutton Switches
Miniature in size, SPST, SPDT, DPST or DPDT circuitry. Wiping, snap action or butt contact. Lightable and non-lightable. 1,000,000 operations rating for some units!

Keyboards
12, 16, and 20 button arrays. Matrix, single pole/common bus, 2 out of 7 (or 8), SPST thru 4PST and coded output circuitry options. 1/2", 11/16", or 3/4" button centers. Many legend choices. Long life rating at logic level switching loads. Tactile feedback even in sealed types. Lighted versions available.



DIP Switches
Complete circuitry choices—SPST, 2PST thru 4PST, DPDT, BCD coded, circuit selector, and tap switch. Total seal capability, with potted base standard and top seal options. Reliable spring-loaded sliding ball contact system. Rocker, slide, side or toggle actuation.

Solid State Relays
UL recognized and CSA certified. Panel or plug-in PC mounts. Up to 25 amp load switching and 250 amp surge capability. Designed to switch inductive loads in minimum package sizes.

ACME® ACME ELECTRONICS
A Division of James Hardie Electronics [Hardie-Trading Ltd. (N.Z.) in Vic.]

VIC. 2-18 Canterbury Rd, Kilsyth 3137. Tel: 729 8999
N.S.W. 120 Beaconsfield St, Auburn 2144. Tel: 648 2255
QLD. 355 Montague Rd, West End 4101. Tel: 44 4131
A.C.T. Electronic Components Tel: 80 4654
S.A. Neil Muller P/L Tel: 272 8011
W.A. J.G. Thomas & Assoc. Tel: 272 7122
TAS. W.P. Martin P/L Tel: 34 2811 Hobart, 31 5545 Laun.

What is better than NiCad for memory back-up?

NEC

COMPARATIVE SIZE

SUPERCAP of course!

Unlike NiCad —

- It never needs replacing or maintenance.
- It does not exhibit discharge memory.
- It can be wired either way. Lack of polarity enables this.
- It can be soldered onto P.C.B.s with other components.
- It can be charged at high and low current rates, i.e. microamps to amps.
- It is completely safe. It will not explode under extremes of temperature, nor will it leak.
- It is small and compact.

Catalogue No.	Cap. (Farad)	Rated V. (V.D.C.)	Max. W.V. (V.D.C.)	Max. ESR* (Ω at 1 kHz)
FA0H105Z	1.0	5	5.5	2.5
FZ0H223Z	0.022	5	5.5	50
FZ0H473Z	0.047	5	5.5	40
FZ0H104Z	0.1	5	5.5	45
FZ0H224Z	0.22	5	5.5	25
FZ0H474Z	0.47	5	5.5	13
FZ0H105Z	1.0	5	5.5	7

*Equivalent series resistance

TECHNICAL INFORMATION AVAILABLE ON REQUEST

SOANAR

SOANAR ELECTRONICS PTY.LTD.
INCORPORATED IN VICTORIA
30-32 Lexton Road, Box Hill, Vic., 3128, Australia.

VICTORIA: 895 0222
N.S.W.: 789 6744
STH. AUST.: 42 8918
QUEENSLAND: 52 1131
WEST. AUST.: 381 9522
TASMANIA: 31 6533

JAYCAR-YOUR No. SOURCE FOR VEHICLE KITS

CONTACTLESS HALL-EFFECT "BREAKER POINTS"

A professionally engineered electronic ("breakerless") contact breaker system.
Yes, only Jaycar has a complete Hall-Effect triggerhead assembly designed to adapt to an extensive number of cars. Each kit contains the following:

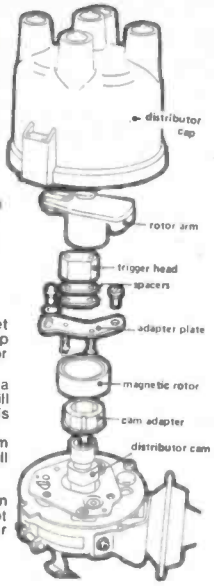
- HALL EFFECT TRIGGERHEAD
- MAGNETIC ROTORS FOR BOTH 4 & 6 CYLINDER CARS
- OVER 6 CAM-LOBE ADAPTORS
- OVER 12 DIFFERENT ADAPTOR PLATES FOR YOUR PARTICULAR DISTRIBUTOR
- OTHER HARDWARE (i.e. SCREWS etc)
- YOU CAN REMOVE THIS SYSTEM AND RE-EQUIP YOUR CAR WITH THE ORIGINAL BREAKER POINTS WHEN YOU SELL THE CAR!
- AS EASY TO INSTALL AS A SET OF POINTS
- INSTRUCTIONS (SIMPLE-TO-FOLLOW) INCLUDED

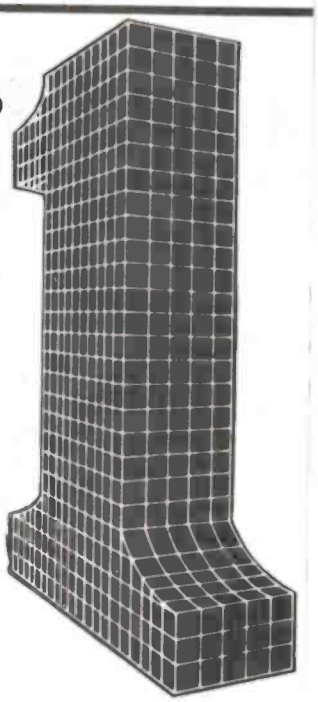
This set is designed to fit most European and Japanese cars. In fact it will also fit many Australian cars fitted with Lucas, Bosch, Motorcraft, AC Delco or Autolite electrics. If you wish to check first, please send SAE for car/distributor list.

SEE EA DECEMBER 1983

Because we have no way of knowing, you get the fitting set for ALL of the distributors available. Basically you end up with a jar full of parts you don't need to use! (Perhaps for your next car?)
Quite frankly, we are amazed that we can supply such a comprehensive kit for this price. To produce a kit that will adapt to the dozens of different distributors around is amazing!
Remember, once you have installed a breakerless system it will never wear out and that part of your system will remain in tune FOREVER.
Cat. KJ-6655
PLEASE NOTE: This system must be used in conjunction with an electronic ignition. The Hall-Effect device will not switch enough current to replace the contact breaker points on their own!

$29.95





TRANSISTOR ASSISTED IGNITION $35

REF: EA JANUARY 1983

Latest version of this fantastically popular kit! The Jaycar kit comes COMPLETE down to the plastic TO-3 transistor covers, genuine heatsink and DIECAST BOX - as used in the original EA unit.
Beware of flimsy kits that use sheetmetal boxes.

This kit is designed to be used with contact breaker points. If you want Hall-Effect breakerless option may we suggest the KA-1505 version of this kit shown elsewhere on the page.
Cat. KA-1506

TRANSISTOR ASSISTED IGNITION HALL-EFFECT "BREAKERLESS" VERSION $36.95

REF: EA DECEMBER 1983

This kit is virtually identical to the KA-1506 except that it contains the interface electronics for the KJ-6655 Hall-Effect triggerhead.
Cat. KA-1505

NEW!! - DELUXE CAR BURGLAR ALARM

(Ref: EA May 1983) Great new design from EA. Ths one is very sophisticated. (Auxillary battery extra) Complete kit of parts.
Cat. KA-1550 **$69.50**

NEW - MOTORCYCLE INTERCOM (Ref: EA March 1984)

Now you can talk freely and safely to your pillion passenger with this handy kit!
Cat. KA-1533 **$39.95**

NEW - IGNITION KILLER

(Ref: EA March 1984) Handy little project fits under your car to foil thieves. At this price can you afford not to have one?
Cat. KA-1535 **$14.95**

THE RED FLASHER - (not illustrated)

A de-luxe Swiss switch with electronics to make it flash plus deterrent stickers to make your car look as if it has an expensive alarm.
Cat. KJ-7000 **$20.95**

NEW!!

"SPARKRITE" LOW COST CAR ALARM KIT

This low cost alarm is ideal for the budget conscious motorist. It has many features:

- ★ 10 amp output relay
- ★ Optional door, bonnet switch input
- ★ Accessory loop
- ★ Horn relay and headlamp output
- ★ Optional entry delay i.e. external disarm switch can be fitted obviating need for entry delay
- ★ Exit delay
- ★ Auto alarm disable. (To meet local noise/enviromental rules)

Staggering value - fully imported from the U.K.
ONLY $39.95
Cat. KJ-6662

ETI340 CAR ALARM

Ref: ETI April 1984

A versatile security system that provides full protection for almost any vehicle. This unit will protect your valuable vehicle from virtually any sort of interference - from hub-cap stealing to being towed away! It does not rely on voltage or current sensing to trip the alarm, but 'resonance microphones'. It can also protect 'perimeter accessories' like driving lights and racks. The project meets the major requirements of car alarms set down by the NRMA. We believe that this alarm is one of the most comprehensive that we have seen. Once again Jaycar has taken the no compromise approach.
The Jaycar kit includes two of the specified resonance microphones, original die-cast box etc. (we supply "chocolate block" multiway connectors as well).
The complete kit is only $69.50 inc. sensors.
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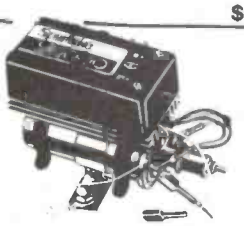

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Sparkrite TX1002 $79

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TX-1002. Slightly lower powered version of the TX-2002. Ideal for most 4 cylinder cars. All fitting pieces included! Cat. KJ-6651

Cat. KJ-6651

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Cat. KJ-6660

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This fantastic Microcomputer was reviewed in ETI Oct 1982. They were very enthusiastic about it, the printer and its legal Apple® software compatibility (around 90%). If you always wanted an Apple but just could not afford it, this could be a fantastic opportunity to get the nearest thing at a fraction of the normal price!!

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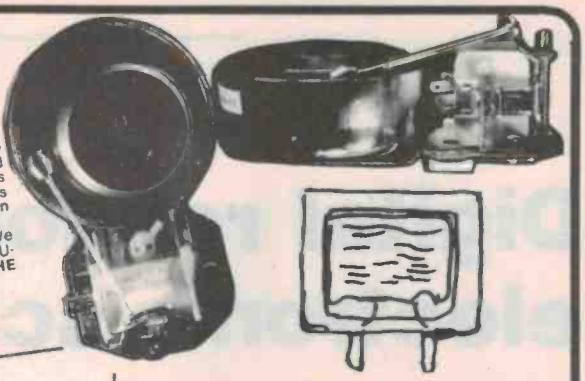

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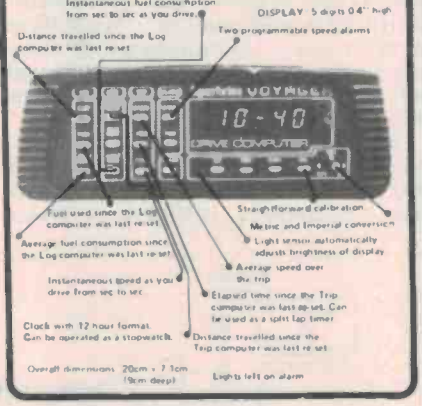

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Digital readout electronic scales

Part 1

Ian Thomas

FOR MANY YEARS I've been toying with the idea of building an electronic weighing scale but up until now I've always put it in the "too hard basket". However, after reading an article in Wireless World by John L. Linsley Hood (*Strain-Gauge Weighing Scale*, Wireless World October 1983) I decided that the time was right. It also seemed a nice idea to have a scale that had multiple ranges to be used for weights from less than a gram to 5 kg and so the specification for my scale began to take shape. As there are a multiplicity of 3½-digit DVM chips available the scale naturally would have ranges of 200 gm, 2 kg and (hopefully) 20 kg with resolutions of 0.1 gm, 1 gm and 10 gm respectively (although the 20 kg proved too much and I had to settle for 5 kg).

All electronic scales consist of a transducer to convert the gravitational force produced by the mass of the item being weighed, electronics to amplify and condition the transducer output and a digital display system to show the result. While the electronics presented no insoluble problems the transducer to convert force to an electrical signal was a different story. While there are many ways of constructing such transducers most require access to sophisticated tools and technology which most of us (myself included) don't have.

The fact that this project has to be buildable by the home constructor eliminated most options such as linear variable differential transformers (LVDTs) or linear potentiometers, as even if one could be made at home you would have a snowball's chance in hell of making it linear enough for this application (a 0.1% linearity LVDT costs more than you or I are prepared to pay and anyway it would take all the fun out of it to buy the heart of the scale!). All of these factors forced me to the conclusion that the right way to construct the transducer was to use some sort of spring which deflects under the load and measure the deflection with a strain gauge.

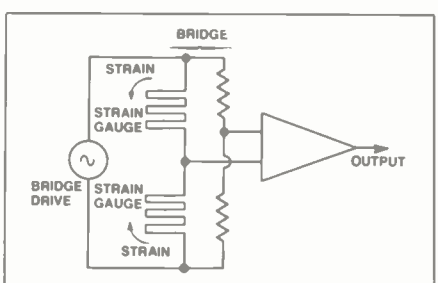


Figure 1. Strain gauge 'bridge' system. Each strain sensor experiences the opposite strain, unbalancing the bridge. The output is then amplified.

Clean lines. I housed the project in a Bimbox which gives clean lines and an ergonomically satisfactory layout.

The strain gauge

For those of you who have not yet run across the term "strain" in the mechanical sense it is defined as the elongation of a member under load divided by the length of the member (mathematically dl/l) and is usually expressed as a percentage. For most springs the ratio of force applied to the strain produced is very linear (the spring is said to be "linear elastic"). A strain gauge works on the very simple principle that if you pull hard on a piece of conducting material then it gets slightly longer and slightly thinner which causes its resistance to increase. Exactly the opposite occurs if you compress it. Because of the lengthening *and* thinning a 1% strain will cause a 2% resistance increase in the material and the whole effect will easily give the linearity we need.

Given that the scale was to be of the strain gauge type the next problem was to decide on the mechanical structure of the spring strain gauge combination. Also, as the strains to be measured are *very* small and there are other effects that change the resistance of conductors (like mainly, temperature) it is infinitely desirable to use strain gauges in a bridge structure where one gauge is compressed and another is stretched by the same load. Other extraneous effects such as temperature should (hopefully) affect both gauges equally and cancel (see Figure 1). This gives the second requirement for the spring structure; it must allow two gauges to be mounted in juxtaposition so they experience strains of opposite sign.

The simplest type of spring I could think of that fulfilled all of these requirements is the simple cantilever. A cantilever is just a

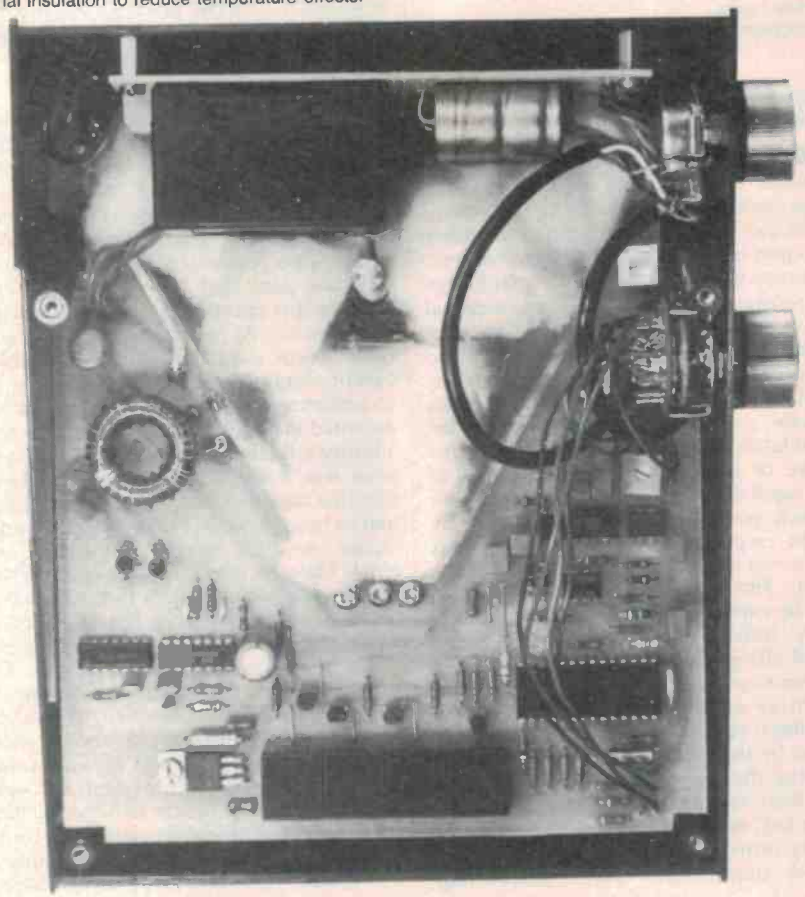
Employing a unique sensing technique, with a strain gauge printed on the pc board, this project avoids the necessity of using difficult to get strain gauge sensors, linear pots, LVDTs etc. It has reasonable precision, four-digit readout, and three ranges of 200 gm, 2 kg and 5 kg full-scale.

bar held horizontally and rigidly clamped at one end. When a load is applied to the other end the top surface of the bar is stretched and the bottom surface is compressed equally; which is exactly the result we want. Therefore, a cantilever or combination thereof seemed to be the right way to go. The next problem to be addressed was what sort of strain gauge to use. Commercially available (and quite cheap) strain gauges consist of foils of fancy alloys bonded to plastic film which are glued to the test piece. The foils are etched in meander line patterns so the long runs of the meander are in the direction of the strain to be measured and strains at 90° to the meander produce (almost) no effect. A possible answer would have been to simply purchase some of these strain gauges and stick them to some sort of spring but I come from a long line of tightwads and wanted a cheaper answer.

The printed circuit strain gauge bridge

I've noticed many times just how surprisingly strong and springy normal epoxy-glass printed circuit board material is and it seemed to me that it would make ideal material for the spring cantilever(s) of the scale. The next obvious thought was not to glue foil strain gauges to the surface but to use the foil that was already there, namely the copper. A meander line structure could be etched in the copper cladding to produce (free!) strain gauges as needed. A further advantage of this structure would be that the foils on both sides of the laminate are thermally in close contact and should track each other. A quick test board was made with only strain gauges on it and lo and behold, it worked! I etched the same pattern on both sides of a 20 mm x 50 mm piece of board as you can see on one arm of the final artwork and used each side as one arm of a bridge. With suitable excitation of the bridge (a 5 kHz square wave with as much power as I could use without burning things up) quite useable outputs were obtained when the board was bent. The only problem was that the two meander line patterns had a very low resistance — about two ohms each.

Inside. Showing general layout and construction. The cotton wool hiding the strain gauge transducer provides thermal insulation to reduce temperature effects.

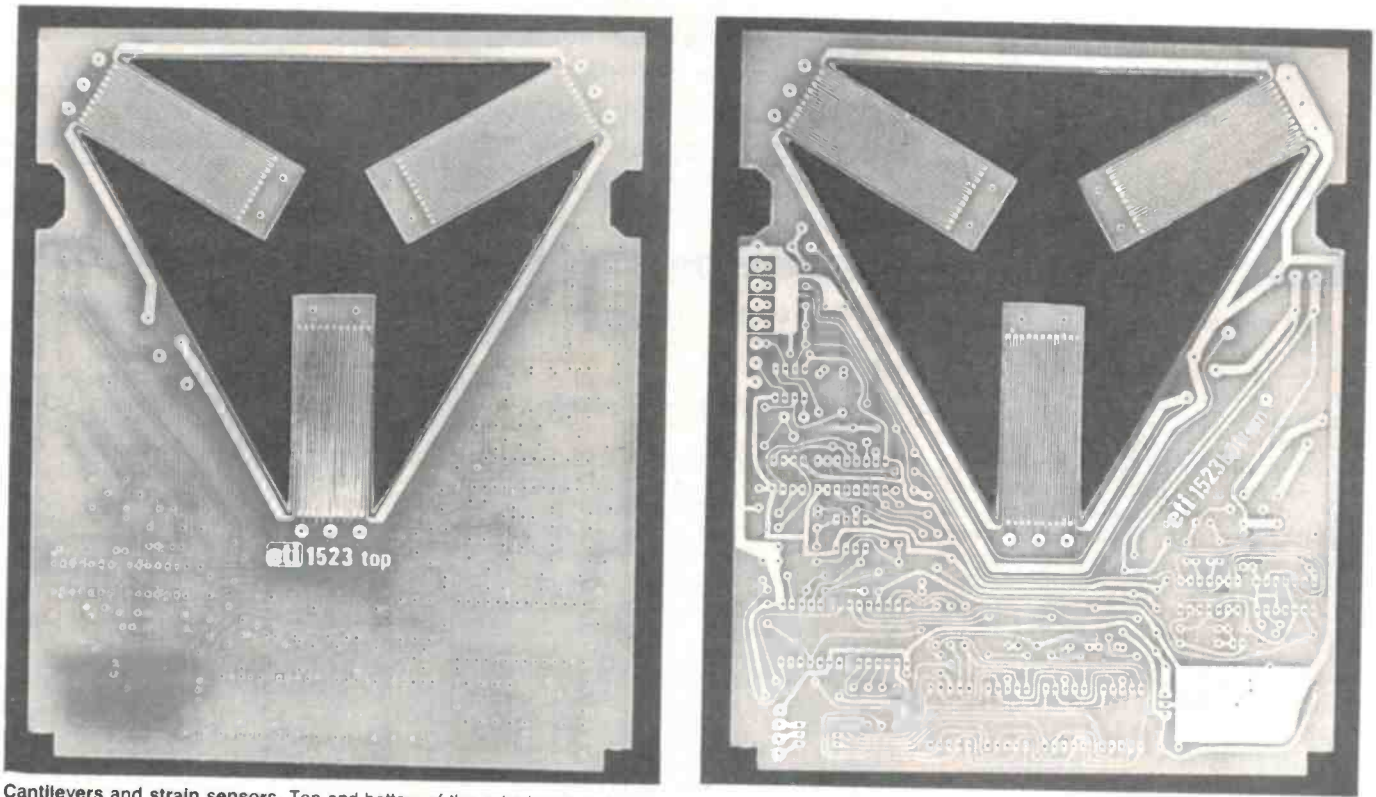


The low resistance presented a problem for the following reasons. If you have a bridge that is perfectly balanced and apply an exciting voltage to it you get nothing out. If you then unbalance it by increasing one arm resistance by 1% and decreasing the opposite arm's resistance by 1% then the output is ½% of the exciting voltage regardless of the actual value of the resistors. Therefore, the exciting voltage should be as big as possible to improve the signal-to-noise ratio of the transducer. The only limit to the magnitude of the exciting voltage is how much power you can drop in the bridge arms. Very low arm resistances mean very high power dissipation in the bridge to get a good signal-to-noise ratio for the transducer; hence the problem.

As I mentioned earlier, temperature effects also change the arm resistances and the very last thing wanted is to have the arms glowing a dull cherry red when you're trying to sniff out microvolt signals!

It's interesting to put a few numbers to this problem to illustrate it. If the arm resistances are one ohm and excited with one volt then they dissipate one watt, which makes them quite hot. If our maximum load of 20 kg gives a 5% resistance change then the bridge output will be 2.5% of one volt, or 25 mV. However, our desired resolution is 0.1 gram or 0.000005 x 25 mV or 125 nanovolts, which is stretching the friendship a bit. To further compound the problem it is necessary to increase the arm resistance four times to double the exciting voltage as power is proportional to E^2. All this says is that, so far as arm resistance is concerned more is better, and even more is better still!

When I sat down and calculated the absolute maximum track length I could cram onto a suitable size cantilever arm the answer came out only just possible, but achievable. A further arm resistance ▶



Cantilevers and strain sensors. Top and bottom of the naked pc board showing the three cantilever arms and the strain gauge meander tracks. Careful board layout has obviated problems with noise being coupled into the sensitive bridge amplifiers.

increase could be achieved by using the thinnest copper laminate available ("½ oz" or 18 μm thick copper). By using 0.5 mm track widths and 0.38 mm spacing a 50 mm x 20 mm area of meander line would have a resistance of about three to four ohms — just usable. In the final design, where there are three separate cantilevers, the total arm resistance worked out at about 10 ohms per side which was (sort of) all right but then created the next problem; how to excite the bridge without wasting power (power-is-heat-is-trouble in anything this sensitive).

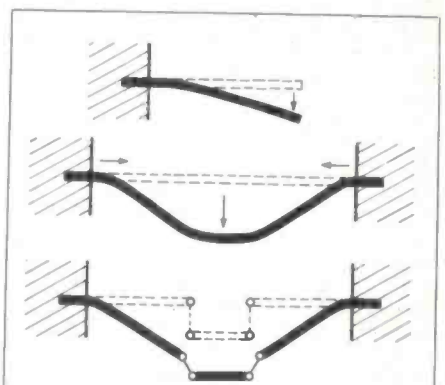


Figure 2. Evolution of the strain transducer: A single cantilever (top) to a dual cantilever (middle) to a multiple cantilever system with pivotted load support.

Bridge drive

It became apparent very early on that the bridge could not be excited with dc as there was no way I was going to build an amplifier with input offset voltages of 100 nV or less. Life is too short as it is. With a total bridge arm resistance of about 20 ohms a casual poke at a calculator reveals that we want an exciting voltage of three to four volts before things start to become awkwardly warm. Given that the power supply gives 15 volts (actually ±8 for reasons that will be discussed later) a method was needed to derive a three or four volt signal with heaps of drive capability without wasting three times as much power in the drive circuitry by straight regulating down. The obvious answer was to use ac drive and use a transformer. This meant that the drive voltage could be varied simply by changing the secondary turns ratio and would give the desired efficiency.

Given that the excitation was to be provided from a transformer the next decision was what frequency to use. The upper limit was set by the bandwidth of the amplifiers following the strain gauge bridge and the lower limit was set by the size of the transformer (or, more accurately, the number of primary turns — I personally find winding toroidal transformers pure, unremitting boredom!). The two limits set the drive frequency at between two and 10 kHz and I finally settled on about 5 kHz.

The load transducer

The heart of the scales is the transducer that converts the applied load to an electrical signal for processing and measurement. It must be linear to at least 0.5% for a resolution of 1 part in 2000; It must be capable of handling extreme overloads without damage (in case someone drops a brick on the weighing pan) and for our application it must be dirt cheap. All in all a challenging specification. As has already been discussed these needs didn't leave a lot of choice except a strain gauge type of transducer and a cantilever spring so the gauges could be mounted in opposite load positions to make a bridge circuit possible. Given that this was what was wanted a mechanical configuration that would tolerate all manner of abuse had to be contrived (I realise that you, dear reader, will be careful, but others may not!). The structure also had to provide support for the weighing pan that was reasonably rigid and, if possible, not consist of any sliding members or messy mechanics that would give hysteresis or tend to stick. One simple cantilever would do this except that when a heavy load was applied the weighing pan would droop sideways — not so good.

I then contrived the idea of having three or four separate cantilever beams in a radial pattern that were rigidly mounted at their outer edges and rigidly attached to the weighing pan in the centre (see Figure 2). This would certainly meet the mechanical ▶

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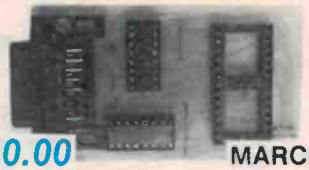

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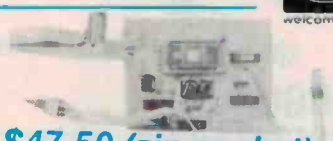

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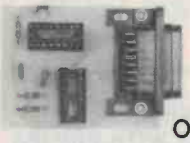

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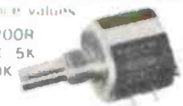
500R 1K 2K 5K
10K 20K 50K
100K



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Price 1 9 $9.50
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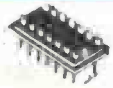

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SPECTROL 43P ACTUAL SIZE

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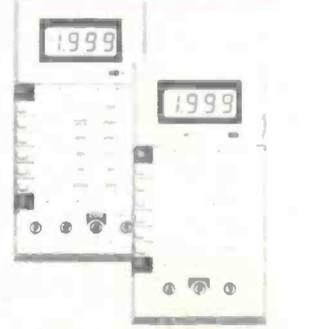

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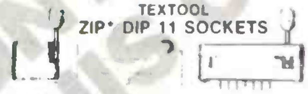

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DIP SWITCHES SPST

cermet single TURN TRIM POT

Spectrol model 63P ACTUAL SIZE

STOCK VALUES
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requirements but had the problems that it was too strong and would not deflect enough (remember that strain gauges measure deflection) and would give heavy side loads to the board supports. Also it would require that the strain gauges be separated into outer and inner halves and carefully connected up so the right gauges were in the right arm of the bridge. The connection problem in itself wasn't major but it made making the artwork for the board messy.

The final answer that seemed to solve all problems was to separate out the three inner ends of the cantilevers and fix them with pivots to the weighing pan support. Since there were three points of attachment to the weighing pan there should be enough sideways support to stop the pan tilting; and also, if the pan did tilt a bit because of an off-centre load, the strain gauges are summed so the overall load measured would be correct. The only problem with this structure was that there are mechanical pivots carrying the load. A quick trip to my friendly local hardware store told what was available here (to be candid, not very much — whatever happened to the shops where you could buy just about anything!). However, I could get ¾" hinges that could possibly be made to do the job. When they came out of the packet they were far too stiff and would have probably given the scale some hysteresis but after oiling and working them they freed up enough to be tried. As the load ends of the cantilever beams move down and sideways under load two hinges had to be used per beam but the bank could stand the expense.

The outer ends of the three beams had to be rigidly attached to some form of base plate and once again I didn't want to get involved with complicated mechanics. Since almost everyone uses tapped spacers and the steel ones are *very* strong this seemed the easiest way to go. I mounted the board on a solid aluminium base with three spacers instead of one at the clamped ends of the cantilever beams. I suspect the resulting structure would survive having a truck driven over it; it certainly was rigid enough. The base plate itself is just a 160 mm square of 2 mm thick aluminium with assorted holes and notches cut in it — no problem.

When I was starting to put this project together I was trying to keep all unnecessary weight off the centre and weighing pan support so I had a threaded bar of aluminium made up to be attached to the centre of the three beams and support the weighing pan but I really think this is unnecessary. A simple ¼" bolt will do just fine (at least they're easy to get). You need two nuts to attach the lower end to the centre of the beams and I just Araldited a third nut to the bottom of the weighing pan to screw it onto the shaft.

The shaft that holds the weighing pan also very nicely provides an end stop for the travel of the scale. If the beams are deflected too far the bottom of the shaft hits the aluminium base plate and prevents anything being broken. I haven't tried dropping a brick on it yet but I suspect it would survive. The whole structure seemed to meet all requirements very nicely indeed.

Reading the strain

As I've already mentioned, we have to amplify *very* low level signals in the scales so the whole electronics design has to be oriented around low noise, accurate performance. To this end it is essential that the earth for ac signals be the earth for everything; hence the split rail power supply. As a general rule "almost earths" or "not quite earths", formed by resistive dividers, are a recipe for trouble in low level systems and should be avoided like the plague. For the cost of one more filter capacitor and a transformer with a centre tap the problem can easily be sidestepped. Since the circuitry has some CMOS, the split rails were kept to ±8 volts which is also quite adequate to power the op-amps. Another very nice thing to do in any design is eliminate the need for regulated power supplies. In this case the exciting voltage is directly related to the supply so the processed output voltage from the bridge would also be proportional to the supply.

However, the cheaper digital voltmeter chips that don't have an internal voltage reference inherently give a digital output that is proportional to the ratio of the input to reference voltage. This means that if the reference voltage is proportional to the supply voltage then the DVM output would be proportional only to the strain — exactly what is wanted! In fact I took this one step further and derived the reference voltage in exactly the same way as the output voltage is processed, in order that the generated reference voltage follow exactly all variations of both the positive and negative rails.

It proved to be rather fortunate that this was done as the digital LED display causes the unregulated positive rail in the final scales to move around quite markedly. The reference and output voltages being held exactly proportional to the supply completely cancel this out and the display shows almost no tendency to affect input levels.

The drive voltage for the transformer was supplied from between the two rails rather than between one rail and earth. having generated a real "earth" earth, the *last* thing to do is knowingly dump very noisy currents onto it so different parts of the same earth track are at different voltages due to IR drops along the track. The most obvious way of generating the excitation voltage is to use a simple saturating core inverter and don't bother with the output diodes.

I've learned from past experience that when saturating core inverter cores saturate ▶

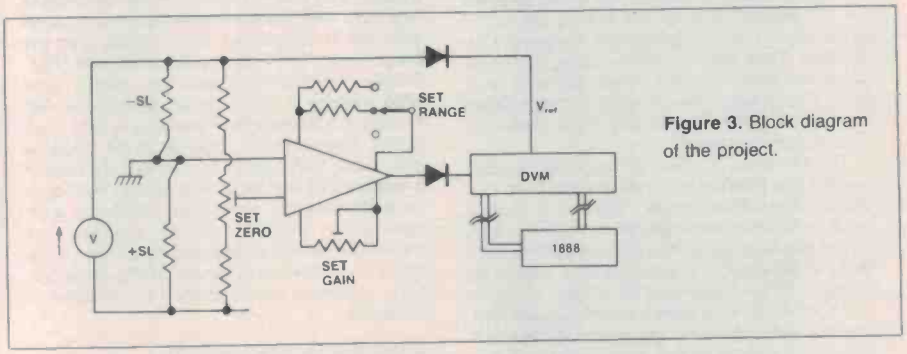
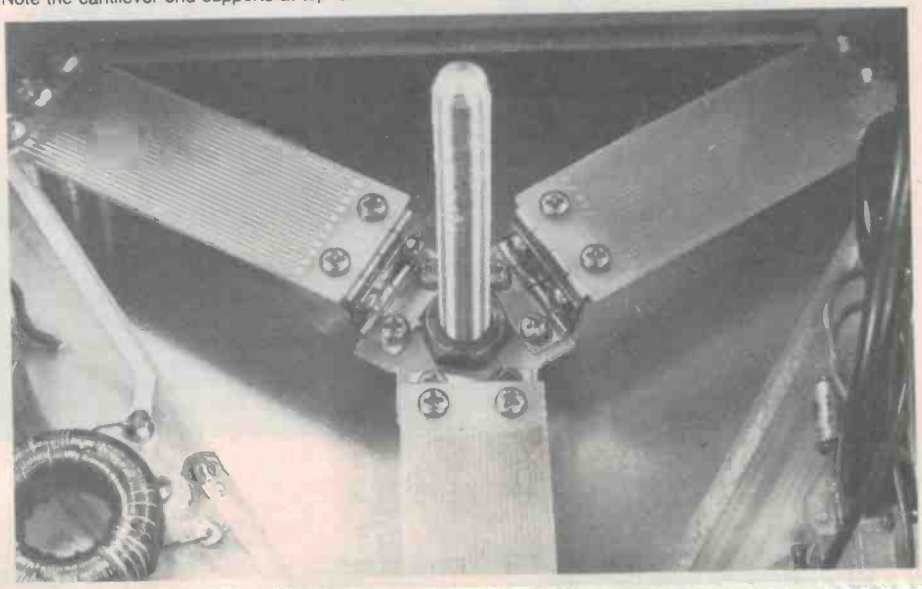


Figure 3. Block diagram of the project.

Load support. View of the completed transducer showing the pan support bolt and hinge pivot system. Note the cantilever end supports at top left.



HOW IT WORKS — ETI-1523

The project can be divided into six separate sections:

1. The power supply;
2. The strain gauge transducer and its associated mechanics;
3. The strain gauge oscillator and bridge drive circuit;
4. The strain gauge output amplifier;
5. The synchronous switch for dc recovery of the amplified ac signal and the associated output dc differential amplifiers;
6. The digital voltmeter and display.

Each part of the circuit will be discussed in turn.

POWER SUPPLY

The power supply is a simple centre-tapped 6 V secondary transformer followed by a full wave rectifier comprising diodes D1 to D4. As the transformer centre tap is connected to earth the two rectified dc outputs take up voltages of ±8 volts for use in the rest of the system. Large filter capacitors, C18 and C19, smooth the power supply sufficiently for use in the project without further filtering or regulation.

THE STRAIN GAUGE

The strain gauge transducer is the heart of the scale and its accuracy and linearity set the performance of the whole instrument. It consists of two groups of three 'meander line' pattern strain gauges etched on 'half-ounce' copper laminate. A meander line is formed on each side of three cantilever beams cut out in the laminate which are arranged in a radial pattern with their outer ends rigidly clamped. The inner ends of the three cantilever beams are free to move under the applied load and are joined by a hinge structure that supports the weighing pan.

When a load is applied all the strain gauges on the bottom side of the beams are compressed and all the gauges on the top are in tension. Thus the two strain gauge patterns on either side form the ideal elements of a bridge structure. The patterns on both sides are connected in series and their centre is connected to ground.

The two ends of the strain gauges are connected to a floating secondary winding of the bridge drive transformer. Thus, any imbalance in the two strain gauge resistances will cause the voltage on the two secondary outputs to be slightly assymetric with regard to ground. These same two secondary outputs are connected to a series resistor chain that has a centre tap that is adjustable. The centre tap is the output to the electronics and the adjustment is to enable any zero offsets to be nulled out.

The inner ends of the three beams are attached to each other via a system of hinges that enable the ends to move freely away from each other when the beams are flexed but still provides mechanical support to the weighing pan. In order to minimise thermal effects the three strain gauge beams are wrapped in a thick layer of cotton wool. This limits heat loss to the ends of the beams and ensures that there are no rapid temperature changes between two strain gauges (see article for details of construction).

OSCILLATOR AND BRIDGE DRIVE

The drive signal for the strain gauges is derived from a simple CMOS oscillator made up from two NOR gates in IC1. The frequency of oscillation is determined by R1 and C2. The output of the oscillator, pin3 of IC1, is divided by one half of the type D flip-flop IC2. This ensures that the output to be fed to the toroid drivers (Q1, Q2) is completely symmetric. The output pins (12 and 13) of the divider are further buffered by two further gates in IC1 before going to the drive transistors to ensure that loading from the transistors does not affect anything else. The two buffered outputs of the divider drive the bases of the two drive transistors (Q1, Q2) via resistors R5 and R6, both of which have 470 pF capacitors in parallel with them to ensure fast switching.

The toroidal drive transformer consists of 120 turns around a ferrite core for the primary, and only 10 turns for the secondary. The primary is tapped exactly at the centre to ensure that the carefully derived symmetric drive produces a symmetric current in the core and no saturation problems. The low voltage secondary is used to excite the strain gauges.

OUTPUT AMPLIFIER

The strain gauge output amplifier is a straightforward two-stage amplifier using a common dual operational amplifier with FET inputs. Each amplifier stage is configured as a non-inverting gain stage with the resistor to ground from the negative input capacity coupled so that each gain stage has unity for low frequencies and dc.

The first stage has a gain of about twenty and is adjustable via RV3 to get the signal well above any noise and allow for a span (full-scale reading) adjustment.

The second stage has an identical feedback network to ground but has switchable feedback resistors from the output to the inverting input to set the three weight range gains. For the heaviest weight range the gain of the second stage is set to just a fraction above unity (to be precise, 1.01) by selecting only a 10 ohm resistor in the feedback. This is in parallel with the 100k resistor R15, which is permanently in the feedback. For the middle range (2 kg) a 10k resistor is switched in parallel with R15 to give an overall resistance of 9.09k. This feedback resistance combined with the 1k to ground (R14, via C9) give the stage a gain of 10.09 or near enough to 10.1. Finally, for the most sensitive range, only 100k resistor is left in circuit. Simple number shuffling will show that the gain in this case is 101 times. Hence, exactly 20 dB steps in gain have been given by using only readily available x10 resistors. The scales may only be calibrated on one range so if any gain variation is found it will be necessary to adjust the values of R16 and/or R17 by paralleling or series-ing resistors. If 1%, or better, 0.5%, resistors are used then no problem is expected.

SYNCHRONOUS SWITCH

The output from the ac amplifier and one side of the bridge drive are both identically converted to dc signals by a synchronous switching process using CMOS analogue switches. The CMOS switches used are CD4053BEs which are three separate single-pole double-throw switches implemented in the CMOS process. Separate 47k resistors, R18 and R19, take the two signals to the inputs of two of the switches (the third is not used). All four outputs of the two switches have 1 µF capacitors, C10 to C13 inclusive, in parallel with them to ground to filter the dc that is recovered by the synchronous switching process.

The control lines that drive the analogue switches are derived from the same line that generates the bridge drive voltage. When one half of the bridge is selected the two outputs will be at one extreme of their excursion and when the other half is selected the two outputs will be at the other. Thus, capacitors C10 and C11 will build up a differential voltage exactly proportional to the ac amplifier output and capacitors C12 and C13 have a differential voltage equal to the bridge drive voltage.

The two operational amplifiers in IC6 form two differential amplifiers whose inputs are the two differential signals from the synchronous switching. Capacitors C12 and C13 are fed directly to the differential amplifier but the outputs of C10 and C11 (the strain gauge signal) are buffered first by unity gain non-inverting op-amps to minimise leakage. The gain of the differential amp for the drive signal is only unity as there is plenty of input level available but the gain of the transducer signal is increased to a little over two to optimise noise and stability performance (the exact value of the gain is chosen more by the value of resistors readily available than by anything else).

For optimum common mode rejection of the diff-amps, resistors R20 to R27 should be 0.5% but in practise 1% would be fine. The output of IC6 (pin 1) is a dc voltage exactly proportional to the input drive ac voltage and the output of IC6 (pin 7) is a voltage exactly proportional to the amplified input from the strain gauges, with both outputs having the same constant of proportionality. This is exactly what is required for the DVM to function correctly.

DVM AND DISPLAY

The DVM chip is a National Semiconductor ADD3501/74C935N which uses a pulse width modulation technique to convert the input dc to a digital reading and then generates all the drive and strobe signals necessary to drive a 3½-digit seven segment LED display. The internal clock for all processing is generated by on-chip gates and the external resistor R28 and capacitor C22. The actual conversion is done by switching one end of the resistor R30 between ground and the reference voltage. As the node between R30 and C21 is one input of a comparator and the other input is the input voltage to be converted, and the whole conversion process consists of keeping these two inputs as near to equal as possible by switching the other end of R30 as described. The only way they can be made equal is for

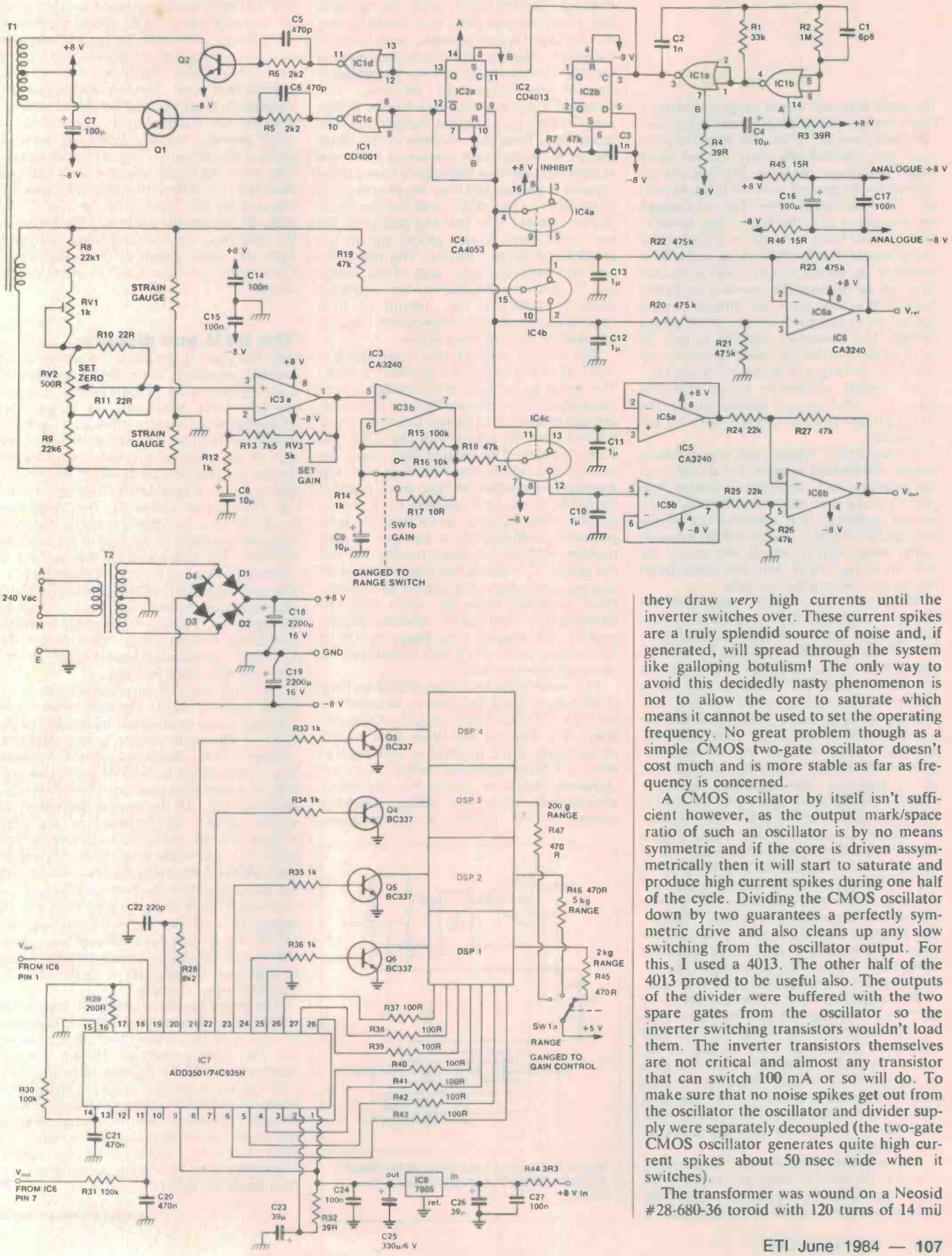
$$\frac{T_{on}}{T_{on}+T_{off}} = \frac{C_{in}}{V_{ref}}$$

The pulse width modulated train thus generated is used to gate the system clock to a system of counters that accumulate the desired reading.

The chip contains all necessary decoders to break the 3½-digits down to seven segment display control lines plus output drivers with sufficient capability to handle the segment lines. Strobe lines out are also provided but these have to be buffered to handle the drive currents required. The four digit-strobe lines are brought out on pins 21 to 24 and are taken through 1k resistors R33 to R36 to the four digit-drive transistors, Q3 to Q6. The collectors of the transistors are taken directly to the common cathodes of the LED displays. The outputs of the DVM are already inverted so they can drive transistors directly. The segment lines have sufficient drive capability to be taken directly to the display and pins 3 to 6 and 26 to 28 carry these signals.

The input analogue signal is filtered by R31 and C20 which are the same value as R30 and C21, the converter mark-space oscillator analogue components. Both are referred to the same analogue ground to minimise offset and noise problems.

Power for the DVM chip is applied to pin 1 for the digital section and via R32 to pin 2 for the analogue section.



they draw *very* high currents until the inverter switches over. These current spikes are a truly splendid source of noise and, if generated, will spread through the system like galloping botulism! The only way to avoid this decidedly nasty phenomenon is not to allow the core to saturate which means it cannot be used to set the operating frequency. No great problem though as a simple CMOS two-gate oscillator doesn't cost much and is more stable as far as frequency is concerned.

A CMOS oscillator by itself isn't sufficient however, as the output mark/space ratio of such an oscillator is by no means symmetric and if the core is driven assymmetrically then it will start to saturate and produce high current spikes during one half of the cycle. Dividing the CMOS oscillator down by two guarantees a perfectly symmetric drive and also cleans up any slow switching from the oscillator output. For this, I used a 4013. The other half of the 4013 proved to be useful also. The outputs of the divider were buffered with the two spare gates from the oscillator so the inverter switching transistors wouldn't load them. The inverter transistors themselves are not critical and almost any transistor that can switch 100 mA or so will do. To make sure that no noise spikes get out from the oscillator the oscillator and divider supply were separately decoupled (the two-gate CMOS oscillator generates quite high current spikes about 50 nsec wide when it switches).

The transformer was wound on a Neosid #28-680-36 toroid with 120 turns of 14 mil ▶

diameter wire and centre-tapped (boring!). These toroids are available both nylon covered and plain and either will do as the plain ones are polished and there are no sharp edges to damage the wire. My first experimental toroid proved to be an utter disaster as it did have sharp edges that cut through the insulation and the ferrite was conductive. It must have been the world's lossiest transformer! A core of this size is capable of handling far higher powers than is needed here but by running the transformer lightly loaded like this gives an almost perfect square wave out to drive the strain gauge bridge. The secondary winding is only 10 turns of fairly solid wire with no centre tap and gives an output of about 2.5 V peak-to-peak. Simple arithmetic shows that this gives the total power dissipation in the strain gauges of a bit over 0.3 watts — not too much.

The secondary winding was very carefully evenly distributed around the toroid over the primary and particular attention was paid to make sure that it was wound in the correct polarity. If it's wound the wrong way all the output voltages will be negative rather than positive which will annoy the hell out of the DVM chip; but more about this in the construction section.

When the output square wave from the bridge is amplified the very fast rising and falling edges will not be reproduced exactly but will be somewhat mangled by the response time of the amplifier. This effect is not just a simple RC response time effect but it blurred and confused by slew rate limiting of the op-amps. This means that for a few microseconds after each edge the amplifier output is in no way a representation of the bridge output but is a function of the step size, the amplifier, capacitive coupling of the drive signal into the amplifier input and probably a few other effects too subtle to bother about. These effects can be collectively removed if, when the ac square wave is reconverted to a dc signal for the DVM, the first few microseconds are ignored. The second half of the 4013 divider is used as a monostable to perform this gating function and its output is a positive pulse for about 20 µs after every transition of the drive signal. This 20 µs allows the op-amp output to settle down before it is used.

The amplifier itself presented no great problem. Two stages of gain were used with the first stage proving the span adjustment needed to set the full scale reading of the scale. The second stage has switchable gain to set the three ranges. Since the overall gain of the block is about 2500 for the most sensitive setting the output has a lot of noise on it but this is removed when the ac is converted to dc.

The only area that did give some problems was the need to keep the output as far away physically as possible from the extremely sensitive input to the amplifier. It only takes a few *femtofarads* (10^{-15} farads) of capacitive feedback for the whole thing to take off, which doesn't help accuracy one little bit. Careful layout of the board made this effect manageable. It is worth noting that the input is *very* sensitive to all forms of capacitive coupling and it will even pick up the edges of the display strobe line pulses if care is not taken. To minimise this, screened leads are used to take the bridge zero-set lines up to the zero adjust pot. The actual lines from the two ends of the strain gauges are deliberately run across the board at high level and low impedance to minimise capacitive pickup and they are also as close as possible to the main earth for the linear section to make sure that any pickup on the two signal lines is also picked up on the ground and doesn't matter. The two resistors that form the other side of the bridge are as close as possible to the amplifier input to minimise the amount of high impedance track and components that are exposed to pick up stray fields.

The resistor network that forms the second half of the bridge is a problem in itself. The strain gauge half of the bridge is very carefully isolated thermally from the ambient and similar care (though not to the same extent) must be taken with the 22k1 and 22k6 resistors. The trimpot that forms the coarse zero adjust *must* be a cermet low temperature coefficient type and I found it desirable to use ½% resistors here, not so much for their accuracy as for their low temperature coefficient (you can get 25 ppm resistors without too much trouble). If you use grade "Z" carbon film trimpots or resistors the zero adjust will wander all over the place as things warm up. Even with low termperature coefficient resistors in the neutral arm, holding your finger on one of the resistors gives about 20% of full scale on the most sensitive setting.

The conversion of the amplified ac back to dc is done using the same technique as in the ETI-1502 Electronic Sling Psychrometer (Dec '83). One of the drive lines to the strain gauge drive inverter is also used to drive a CMOS analogue switch as a synchronous switch to charge two capacitors alternatively from the bridge amplifier output. A 47k resistor in the analogue switch, combined with the two capacitors ters out the noise from the op-amps and gives a clean and stable dc signal for the DVM. Experience has taught me that when dealing with low level dc signals there is no such thing as absolute earth and if you want to do an accurate measurement you have to establish a "local" earth and refer all voltages to that point. For this reason the two voltages that are formed on the two capacitors are not assumed to be referred to any earth potential but the difference between them is the actual voltage to be measured. The two capacitor voltages are buffered then fed to a differential amplifier which is referred to the local earth for the DVM chip. In exactly the same way (but without the buffering) a reference voltage is derived from the strain gauge drive so that variations in drive voltage have no effect on the output.

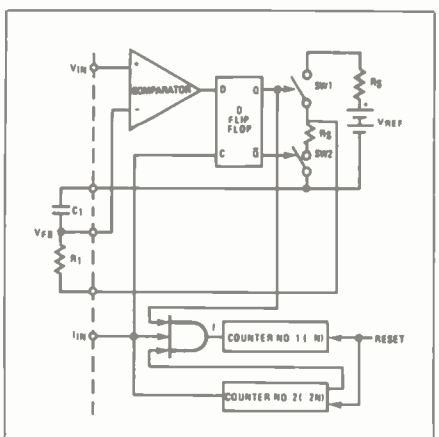


Figure 4. Analogue input circuit of the National ADD3501/74C935N DVM chip used in this project.

The DVM and display

The last part of the circuit, which gave no trouble whatever, is the DVM and associated digital display. (I must admit I'd expect no less from National). Its a perfectly straightforward device that uses a pulse width modulation technique to avoid the use of any external precision components. Inside the chip is a comparator whose output is fed to a type-D flip-flop (see Figure 4). The outputs of the flip-flop drive two analogue switches that connect either the reference voltage or ground to an external resistor. The other end of this resistor is connected to a low leakage capacitor and to the inverting input of the comparator (the non-inverting input is the input voltage to be digitised). The whole ensemble forms an oscillating feedback loop which holds the inverting comparator input equal to the non-inverting input voltage.

The only way this can occur is if the mark/space ratio of the D flip-flop output (and the driven end of the resistor) is equal to the ratio of the input voltage to the reference voltage. This carefully generated mark/space ratio signal is used to gate clock signals to counters to generate the actual digitised reading. All the display decoding and strobe signals are included in the chip except for the digit-select drivers (which need an awkwardly large drive capability for CMOS). I used four separate transistors for the digit-selects as they have to sink up to about ¼ amp if the display digit has all segments on. This, incidentally, is why the DVM chip is such a magnificent noise generator; you can have ¼ amp currents being switched on and off at about 1 kHz. It really can be hard to contain.

The power supply for the scale is about as simple as a power supply can be and consists of a pc mounting transformer, diode bridge and two filter capacitors. It's on a small separate board only because thats the only way it could be fitted in the box. The supply must be loaded to give the desired ±8 V, though Ferguson seem to have allowed a few extra turns on the output winding to allow for losses and if it is very lightly loaded the CMOS is made to work harder than might be desired. ●

. . . continued next month

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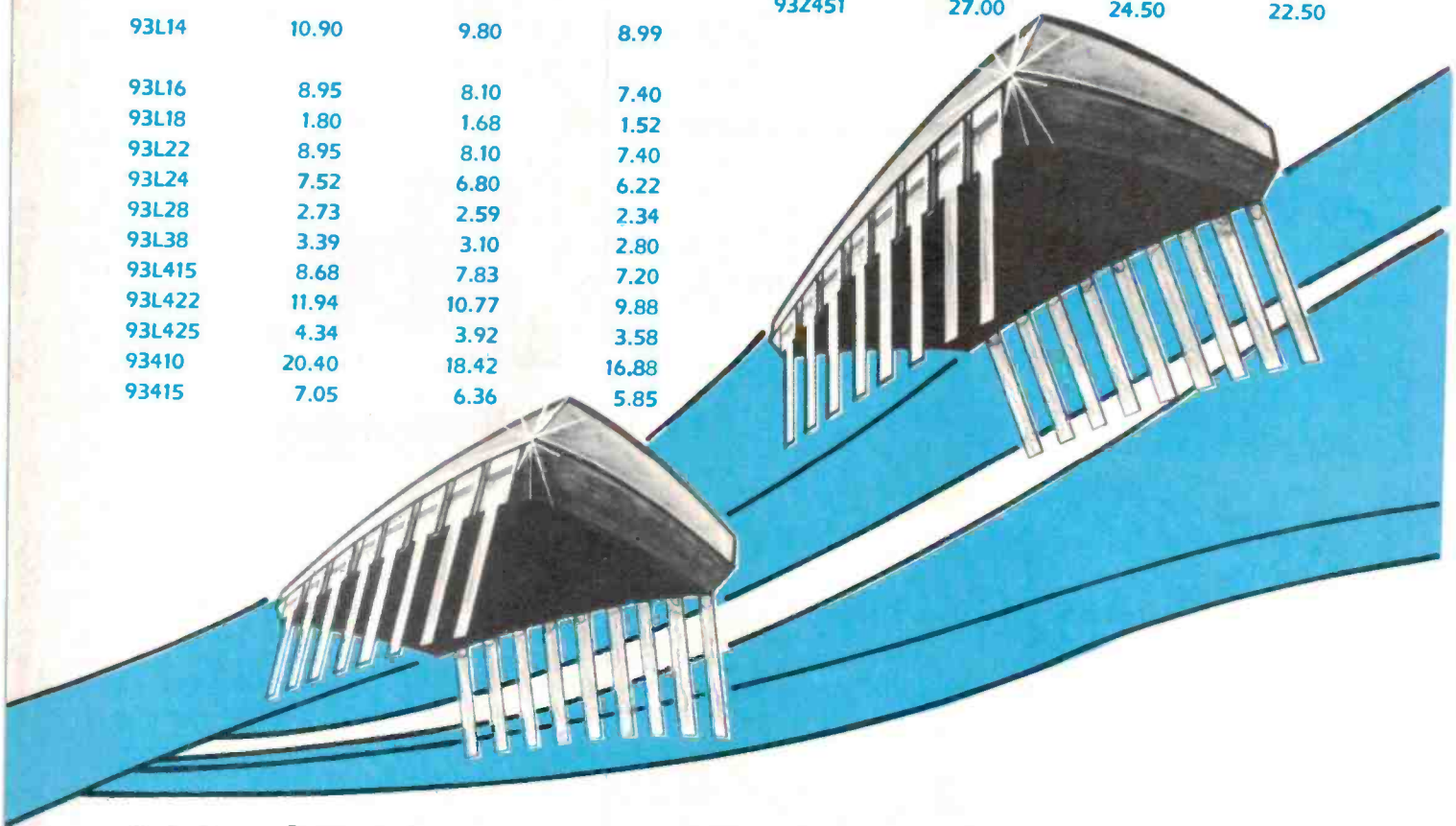

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M74HC27B1	Triple 3 - Input Nor Gate
M74HC30B1	8-Input Nand Gate
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'Goof-proofing' the '162 power supply

Roger Harrison

The ETI-162 Power Supply has been a very popular project since we published it in the December 1982 edition. However, while current limit protection was provided, the supply isn't wholly 'goof-proof'. This little modification fixes that.

WHILE WE RECEIVED the 'usual' rash of calls and letters shortly after the project appeared — constructors using TIP31s instead of TIP32s for the series-pass transistor, shorting leads 2 and 3 of the 317 regulator, putting diodes in back to front, etc — few readers reported any unusual or common problems and the 'help' calls and letters trailed off as is the general pattern. However, towards the last quarter of 1983, we began to receive a 'run' of calls all reporting the same symptom — destruction of Q1 at switch-on or switch-off.

Now this puzzled us, as the original ETI-162 had been doing sterling service in the ETI lab since it was built and we could not reproduce the fault. Until, that is, a technical college lecturer and a reader independently gave us 'the clue'. With a short circuit on the output (or with the project operating in the current limit mode at or near maximum current output), Q1 would be destroyed when the supply was switched off, or in some cases, when it was switched on in that condition.

After some investigation, we could reproduce the problem (fzzst went several TIP32s!). Delving further into the switch-off conditions, it seems that the −10 V rail may rapidly 'collapse' following switch-off. When this occurs, IC1 'lets go' of the 'adj.' terminal (pin 1) of the 317 regulator which is then free to draw more current through R3, turning Q1 on harder. Now, there's 5000 uF of capitance on the rectifier output and the charge held in C1-C2 will be 'dumped' through the emitter-collector junction of Q1 and the short (or low resistance load) on the output. This can cause the emitter-collector junction of Q1 to fuse. Exit Q1. If Q1 goes short circuit, next time you turn the power supply on you'll get peak current through the load, or, if you've removed the load, you'll get 36 V or so on the output. Generally, this causes R7 to smoke furiously! Tsk, Tsk.

If the −10 V rail rises more slowly than the main rectifier output after switch-on, then IC1's output may not control the adj. terminal of the 317 regulator, as before, with the same result: Exit Q1.

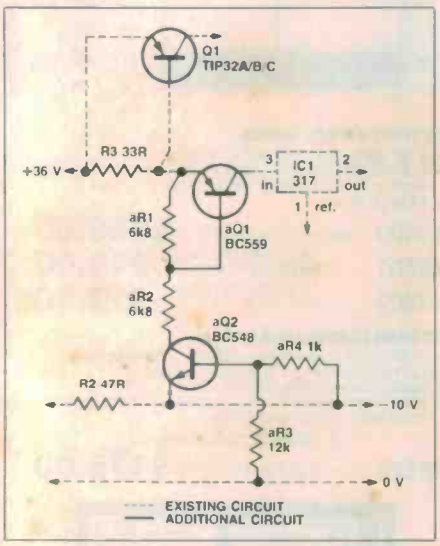
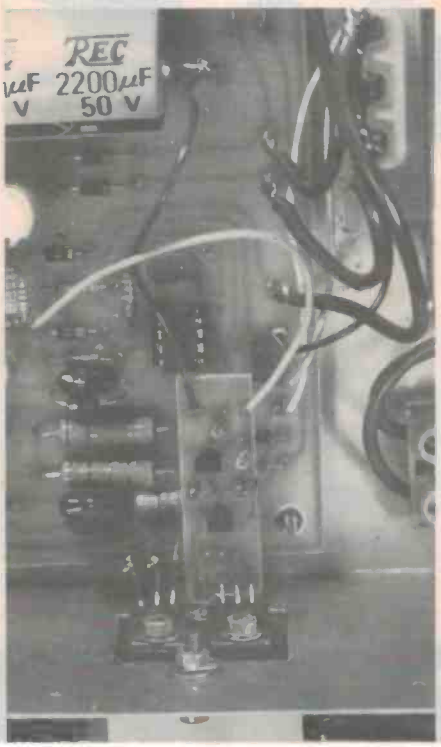


Figure 1. When the −10 V supply rail is present, aQ2 is biased on, which turns on aQ1 via aR1 and aR2. Thus, current can flow through IC1, the 317 regulator. When the −10 V rail drops below about 0.5 V, aQ2 turns off, turning off aQ1, preventing IC1 from drawing current and saving Q1 from destruction as described in the text.

The modification installed. About $2 worth of bits is all it takes! Note where the 0 V and −10 V rail leads connect. (Pay no attention to the resistor paralleled across R2).



The modification

Providing current-limit protection during switch-on and switch-off is simple. Just ensure IC1 can draw no current when the −10 V rail is not present. The circuit in Figure 1 shows how it's done and was suggested by a reader.

Technical Editor, Geoff Nicholls, lashed up a trial run and tried it out. Problem cured. A pc board was laid out, etched up, constructed and installed. The result you see in the accompanying photograph. The component overlay for the pc board is shown in Figure 2. Assembling the board is straightforward — but watch the orientation of the transistors and note which is which or you might be back where you started! Attach the 'oV' and '−10 V line' flying leads. These should be about 100 mm long.

Installing it is simple. First, desolder the three tinned copper wire leads between the 317 pins and the pc board — at the 317 pins. Bend these wires forward slightly, so that they stand almost straight up from the board. Next, unbolt the 317. Solder it to the '162a pc board, at full lead length. Bend the 317 flat across the board and, holding it vertical, aQ2 uppermost, copper side toward the front panel, solder the three tinned copper wire leads to the appropriate holes in the little board.

Now bend the board back down so that it lies roughly parallel to the main board, bend the 317 back up and bolt it in place, taking care to correctly replace the insulating bush and mica washer. Use a multimeter to check there are not shorts between the 317 tag and chassis. Now solder the '0 V' and '−10 V line' leads in place, as can be seen in the photograph.

That's it. Give the whole thing a final check, then switch on and check it out.

Your ETI-162 Bench Supply is now goof-proof! ●

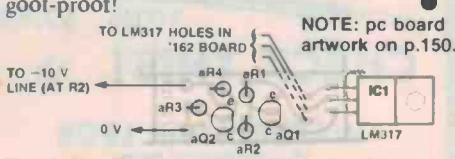


Figure 2. Component overlay for the ETI-162a pc board.

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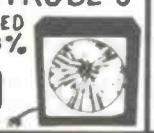

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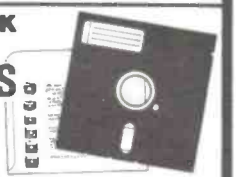

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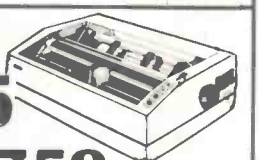

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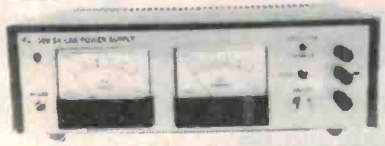

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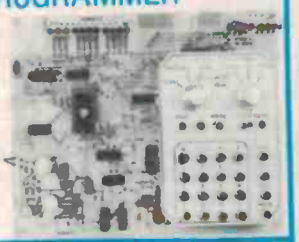

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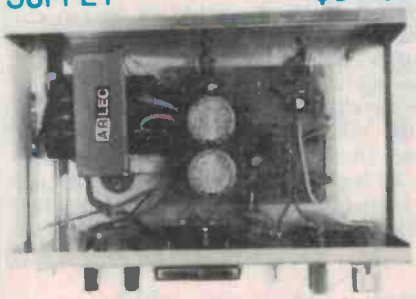

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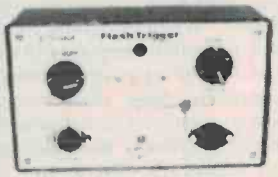

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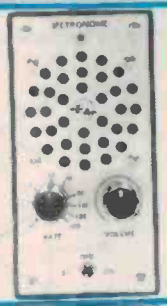

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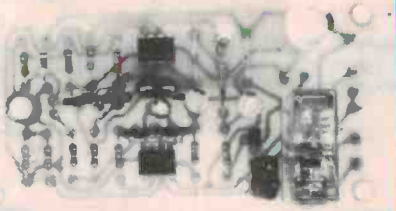

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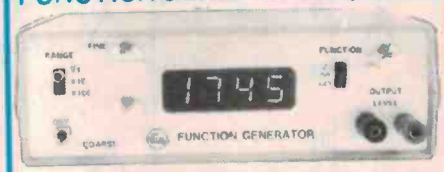

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The ins and outs of logic gates

Digital inverters, buffers and logic gates can come in either IC form or made up from discrete circuitry. Which type should be used in a particular application? Ray Marston answers this and many other 'logic' questions in this article.

Ray Marston

PULSE INVERTERS, buffers and gates are the most basic elements used in digital electronics. When designing complex digital circuits, it is often necessary to work out the most economic or cost-effective method of implementing these elements. Sometimes it's best to use discrete components (diodes-resistors-transistors) to make an element, and at others it's best to use a dedicated CMOS chip. How do you make the choice? I'll explain that in the next few pages.

The best known logic gates are the OR, NOR, AND, NAND, EX-OR and EX-NOR (EXclusive) types. Less well known is 'majority' logic which, as the name implies, gives an output only when the majority of an odd number of inputs are high. Majority logic is useful in 'voting' and psuedo-intelligent applications, such as decision-making in robotic and security systems.

Buffers and inverters

The most basic type of digital circuit is the simple pulse inverter. Figure 1a shows the standard circuit symbol of the inverter, and Figure 1b shows the 'truth', or operational table; Figure 1c shows a discrete resistor-transistor version of the inverter.

In digital circuits, input and output signals are either at zero, or logic 0 values, or at the full supply-rail voltage of logic 1 value. Thus, in Figure 1c, when the input is low (at logic 0) the transistor is cut off and the output is pulled high (to logic 1) via R2, and when the input is high the transistor is driven to saturation and the output is pulled to zero volts. The importance of the Figure 1b truth table is that it illustrates this information in short-hand form.

The standard inverter is the most versatile of all logic elements. It can be used to convert an OR gate to a NOR type, or vice versa, or to convert an AND gate to a NAND type or vice versa. A pair of inverters can be used to make a bistable, monost-

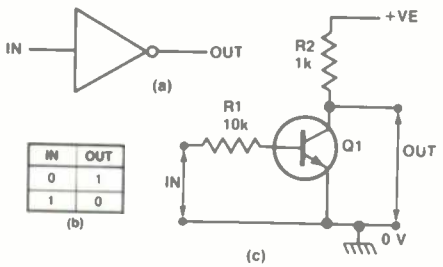


Figure 1. (a) Standard symbol and (b) truth table of a digital inverter with (c) a resistor-transistor version of the unit.

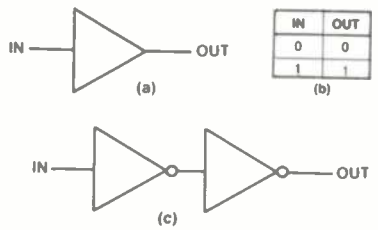


Figure 2. (a) Symbol and (b) truth table of a non-inverting buffer stage which can be made by (c) cascading two inverter stages.

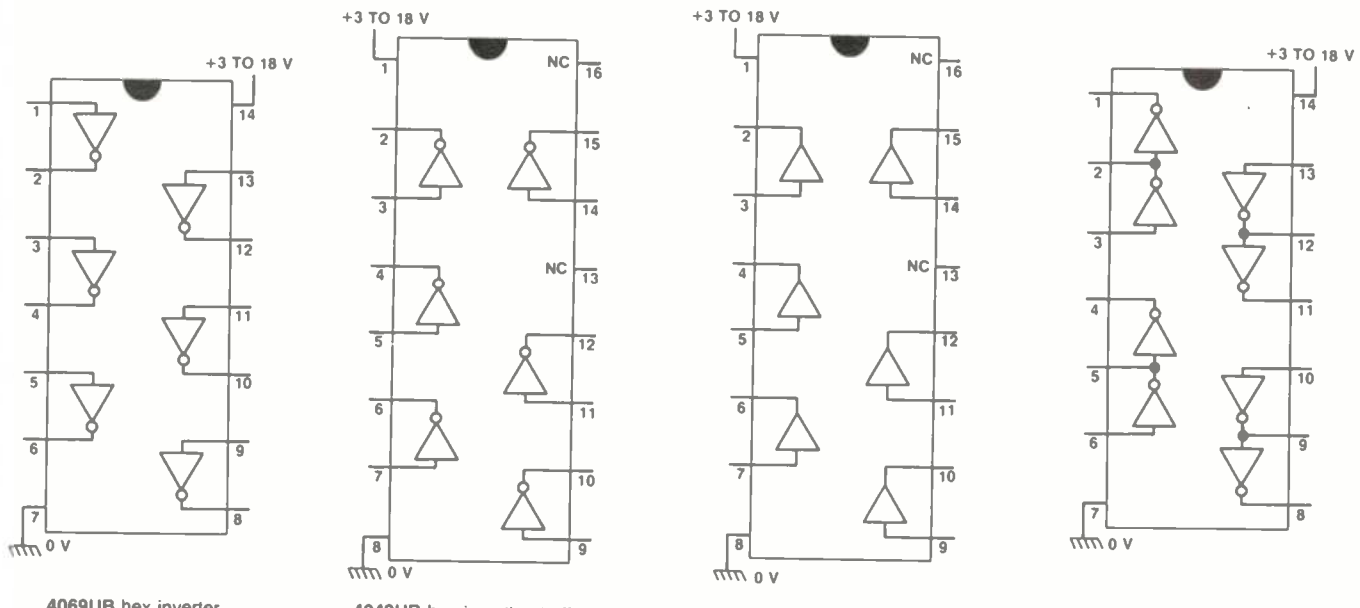


Figure 3. Five popular CMOS inverter and buffer ICs.

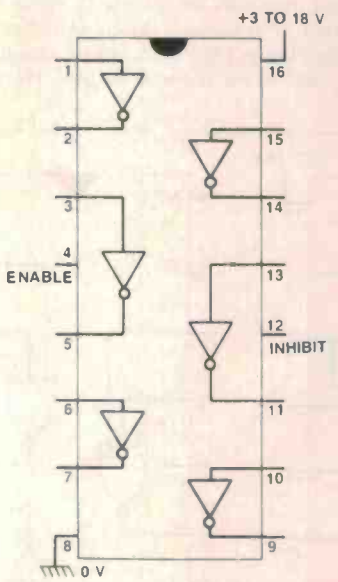
able or astable multivibrator, etc. Usually, a practical inverter has an input impedance that is high relative to its output impedance, and can be used as an impedance 'buffer'.

Not all buffers are of the inverting type. Figure 2a shows the standard circuit symbol of a non-inverting buffer stage which can be made by cascading two inverting elements as shown in Figure 2c.

Inverters and buffers are available in dedicated CMOS IC form, and Figure 3 gives details of five popular examples. The 4041, 4049 and 4069 types use the unbuffered (UB) low-gain form of CMOS construction, and the 4050 and 4502 use the high-gain buffered form of construction.

The 4069UB is a simple general-purpose hex inverter, housed in a 14-pin package, with 'standard' output drive capability. The 4049UB hex inverting buffer and the 4050B hex non-inverting buffer, on the other hand, have high output drive capability and are specifically intended to drive TTL loads; they can accept input signals far greater than the supply voltage so can be used to give signal-level translation between CMOS and TTL circuits.

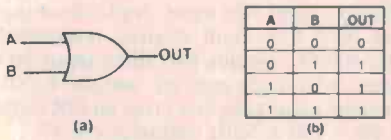
The 4041UB also has high output-drive capability and can be used to drive TTL, but can not accept input signals greater than its supply voltage. The device is a quad invert/non-invert buffer. If, for example, an input is applied at pin 3, an inverted output is available at pin 2 and a non-inverted output at pin 1.



4502B tri-state hex inverting buffer. Normally pins 4 and 12 are grounded. If pin 4 is high the outputs go into the high-impedance tri-state mode. If pin 12 is high all outputs go low (if not in the tri-state mode).

The 4502B is a hex inverting buffer capable of driving TTL loads, and has a tri-state output which can be selected via pin 4; when pin 4 is low the IC gives normal inverting operation, but when pin 4 is high all outputs go into the high-impedance tri-state mode. The IC also has an INHIBIT control terminal (pin 12), which is normally held low but which drives all outputs to ground (in the 'normal' mode) when pin 12 is taken high.

The basic guidance rules for using inverters and buffers in practical circuits are simple. If you need a large number of stages, use as many dedicated ICs as necessary. If you get to the point where you are short of just one or two stages, see if you can make them from spare stages of existing logic ICs (I'll show how later) or, failing that, consider using simple resistor-transistor stages of the type shown in Figure 1c.



A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	1

Figure 4. (a) Symbol and (b) truth table of a two-input OR gate.

OR and NOR gates

Figure 4a shows the standard symbol of a two-input OR gate, and Figure 4b shows its truth table. As indicated by its name, the output of the OR gate goes high if any of its inputs (A OR B, etc) go high. The simplest way to make an OR gate is to use a number of diodes and a single load resistor, as shown in the three-input OR gate of Figure 5. The diode OR gate is reasonably fast, very cost effective, and can readily be expanded to accept any number of inputs by adding one more diode to the circuit for each new input.

Figure 6a shows the standard symbol of a two-input NOR gate (which functions like an OR gate with an inverted output) and Figure 6b shows its truth table. Figure 7 shows how a diode OR gate can be converted to a NOR type by feeding its output through a transistor or IC inverter stage.

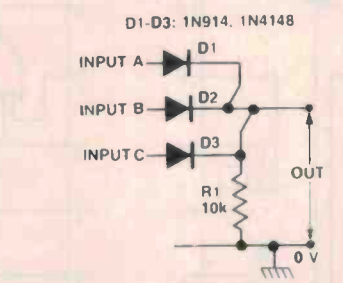
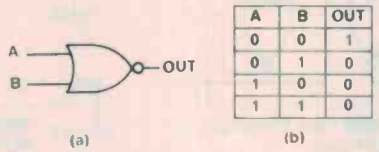


Figure 5. Three-input diode OR gate.



A	B	OUT
0	0	1
0	1	0
1	0	0
1	1	0

Figure 6. (a) Symbol and (b) truth table of a two-input NOR gate.

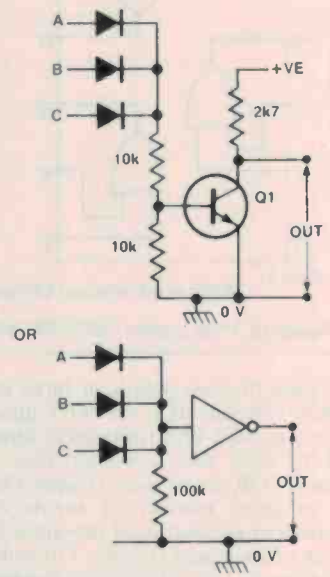


Figure 7. The diode OR gate can be converted to a NOR type by feeding its output through a transistor or IC inverter.

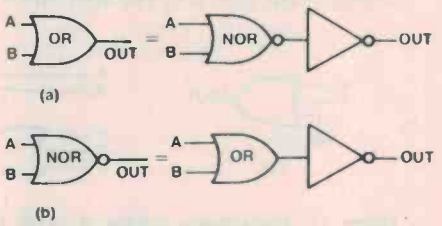


Figure 8. An OR gate can be made from a NOR gate, or vice versa, by taking the output via an inverter.

Figure 8 drives this lesson home by pointing out that an OR gate can be made from a NOR gate plus an inverter, and a NOR gate can be made from an OR gate plus inverter.

Figure 9 shows that a NOR gate can be made to act as a standard inverter, and an OR gate can be made to act as a non-inverting buffer, by either grounding all but one of the inputs or by connecting all inputs in parallel.

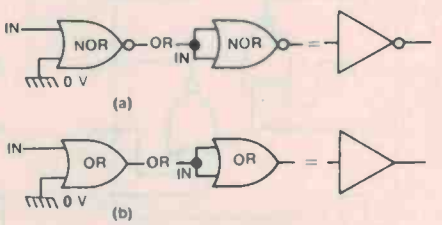


Figure 9. A NOR gate can be converted to an inverter and an OR gate can be converted to a non-inverting buffer. ▶

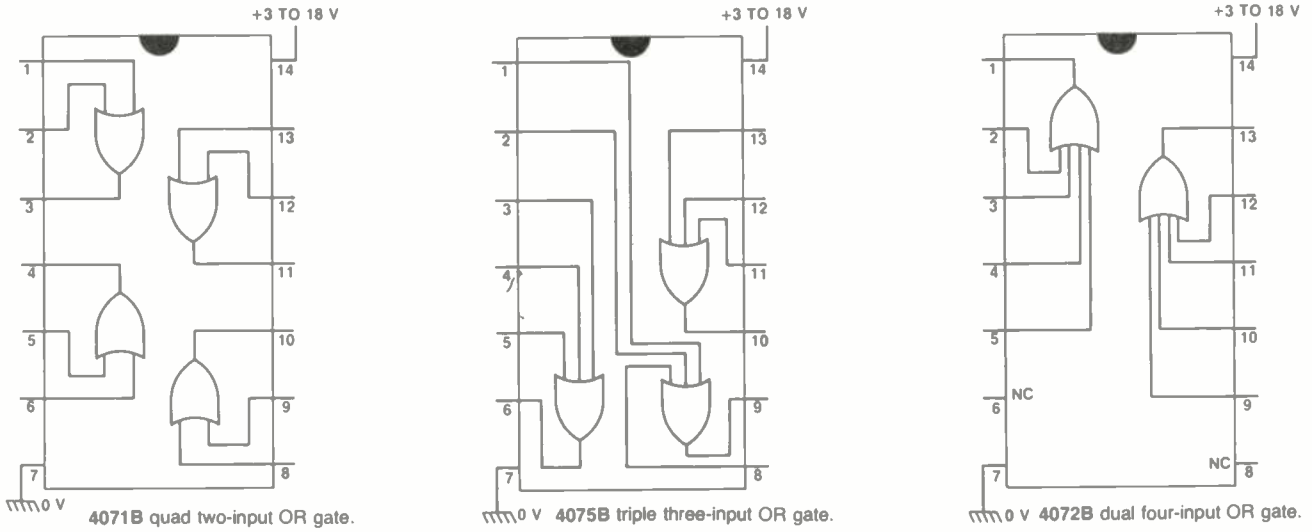


Figure 10. Three popular CMOS OR-gate ICs.

Figure 10 gives details of three popular CMOS OR gate ICs, the 4071 quad two-input type, the 4075 triple three-input type and the 4072 dual four-input type. When using IC OR gates, note (Figure 11a) that the effective number of inputs can be reduced by grounding all unwanted inputs, or can be increased (Figures 11b and 11c by adding more OR gates (either integrated or discrete) to one of the inputs.

Figure 12 gives details of five popular CMOS NOR gate ICs. The 4001, 4025 and 4002 are quad two-input, triple three-input and dual four-input devices respectively. The 4000B contains two three-input NOR gates and a single inverter, and the 4078B is an eight-input gate that gives an OR output at pin 1 and a NOR output at pin 13.

Note that, since a NOR gate is equal to an OR gate with an inverted output, the effective number of inputs of a NOR gate can be increased or reduced by using the techniques that have already been shown in Figure 11.

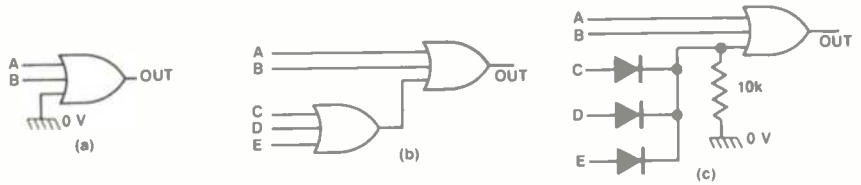


Figure 11. The effective number of inputs of a CMOS OR gate can be reduced (a) by grounding all unwanted inputs, or increased (b or c) by adding more OR gates to one of the OR inputs.

Figure 13 illustrates a simple example of logic design using OR and NOR gates and inverters, the aim being to design a simple low-power tone generator (using a PB-2720 piezoelectric transducer) that can be activated via any one of four inputs. Look first at Figure 13a. At first sight, the design seems to call for the use of a four-input OR gate, with its output feeding to a gated tone generator. A suitable tone generator can be made by connecting a two-input NOR gate and an inverter in the standard astable configuration shown, but this astable is gated on by low input signals, so (in Figure 13a) the required circuit action can be obtained by interposing an inverting stage between the output of the four-input OR gate and the input of the astable. The Figure 13a design thus calls for the use of three ICs.

Figure 13b shows a simple rationalisation of the Figure 13a circuit which enables the IC count to be reduced to two. Here, the

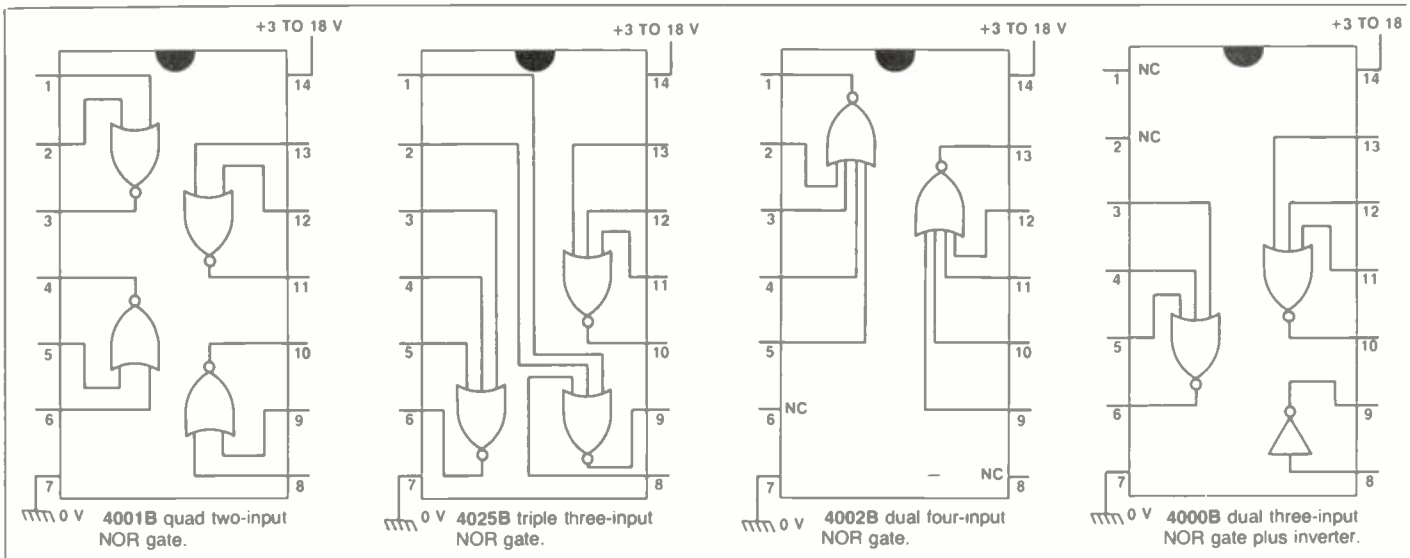


Figure 12. Popular CMOS NOR-gate ICs.

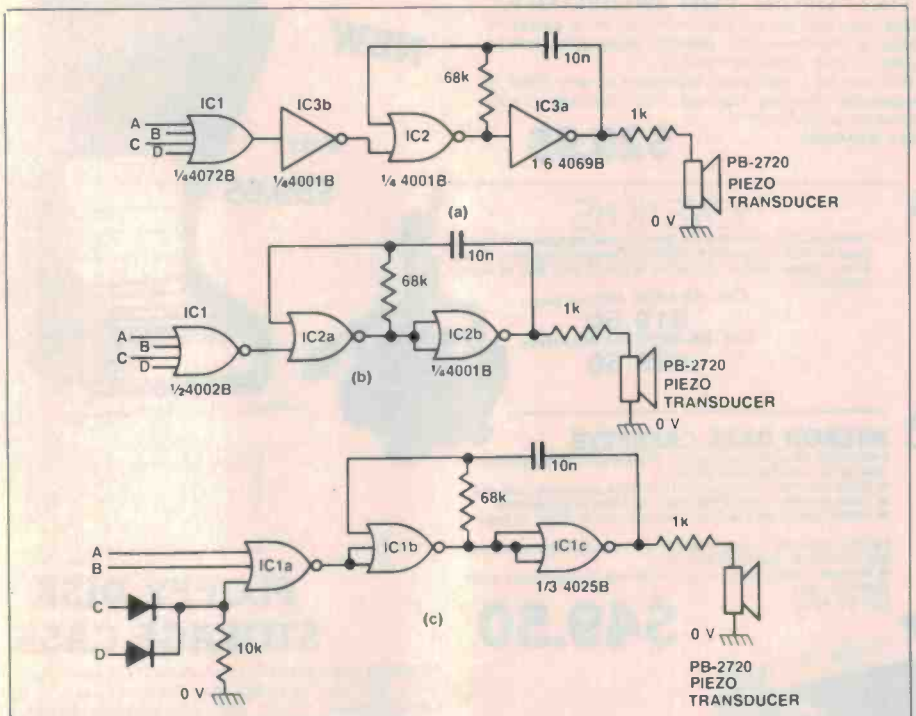
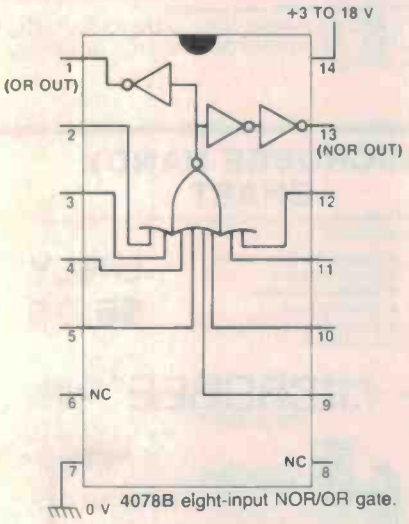


Figure 13. Low-power tone generator activated by any of four 'high' inputs. The 'over-designed' version shown in (a) uses three CMOS ICs but the rationalised design shown in (b) uses only two CMOS chips. In (c) the design is further rationalised so that it uses only a single IC.

four-input OR gate plus inverter of Figure 13a is replaced by a four-input NOR gate, and the inverter section of the astable is made from a two-input NOR gate with its inputs shorted together.

Finally, Figure 13c shows how the design can be further rationalised so that it uses only a single IC (a triple three-input NOR gate) and a couple of diodes. Here, the astable is made by converting a three-input NOR gate to a two-input type by shorting two of its inputs together, and by shorting all three inputs of another gate together to make an inverter. The input gate of the circuit is converted to a four-input type by connecting a two-input diode OR gate to one of its inputs.



4078B eight-input NOR/OR gate.

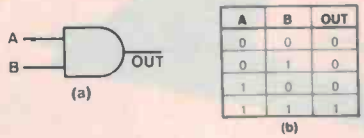


Figure 14. (a) Symbol and (b) truth table of a two-input AND gate.

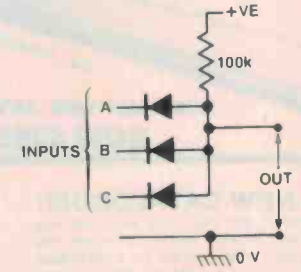


Figure 15. Three-input diode AND gate.

AND and NAND gates

Figure 14 shows the standard symbol and truth table of a two-input AND gate which, as indicated by its name, gives a high output only when all of its inputs (A AND B, etc) go high. The simplest way to make an AND gate is to use a number of diodes and a single load resistor, as shown in the three-input AND gate of Figure 15: more inputs can be obtained by adding one extra diode for each new input.

Figure 16a shows the standard symbol of a two-input NAND gate (which functions like an AND gate with an inverted output) and Figure 16b shows its truth table.

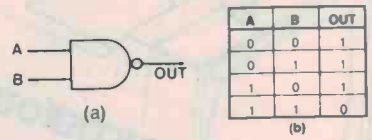


Figure 16. (a) Symbol and (b) truth table of a two-input NAND gate.

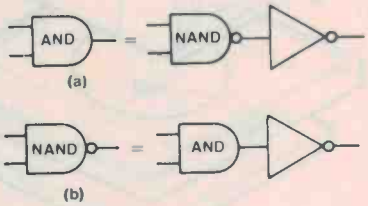


Figure 17. An AND gate can be made from a NAND gate, or vice versa, by taking the output via an inverter.

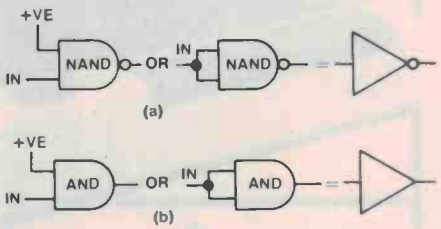


Figure 18. A NAND gate can be made to act as an inverter and an AND gate can be made to act as a non-inverting buffer.

Figure 17 shows how a NAND gate can be made from an AND gate and an inverter, and an AND gate can be made from a NAND gate and an inverter. Figure 18 shows that a NAND gate can be made to act as an inverter and an AND gate can be made to act as a non-inverting buffer either by wiring all but one of the inputs to the positive (logic 1) rail or by wiring all inputs in parallel.

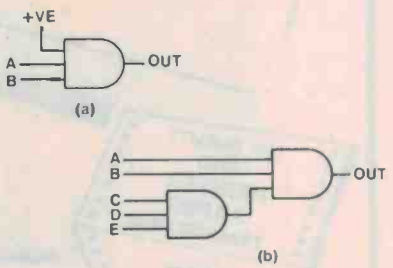


Figure 19. The effective number of inputs of an AND or NAND gate can easily be (a) reduced or (b) increased.

Figure 19 shows that the effective number of inputs of an AND or NAND gate can be (a) reduced by wiring all unwanted inputs to the positive supply rail, or (b) increased by wiring extra AND gates to one of the inputs. ▶

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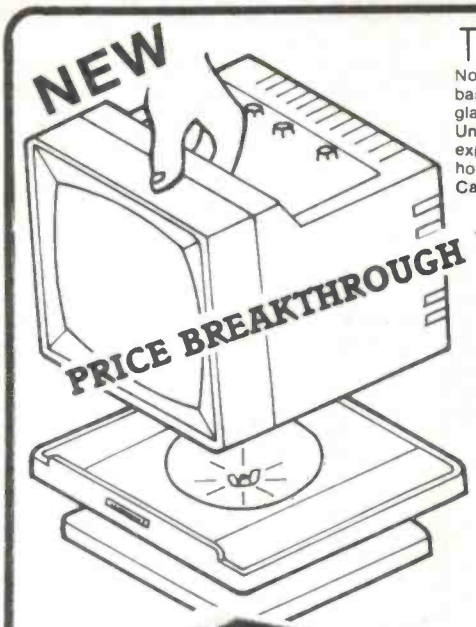

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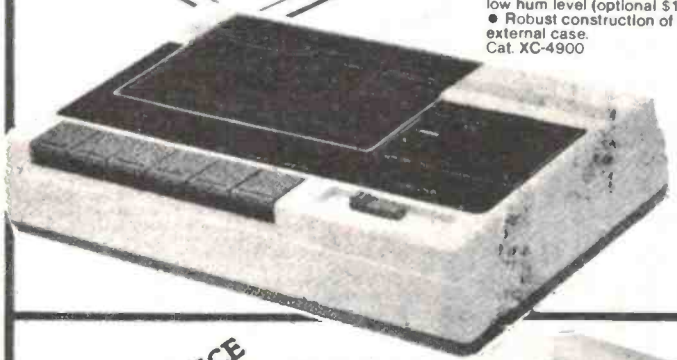

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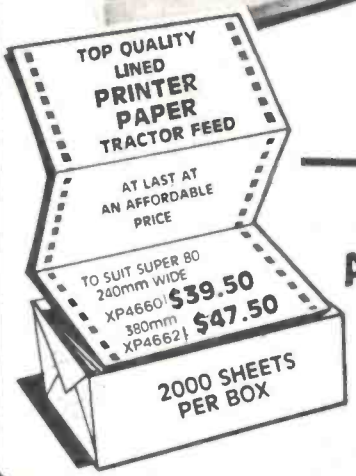

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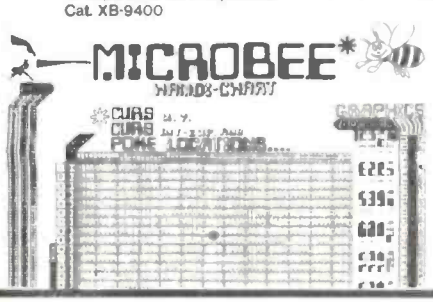

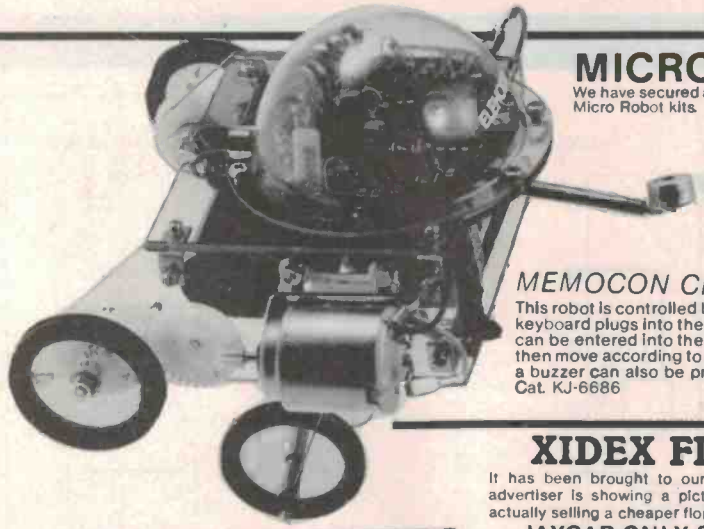

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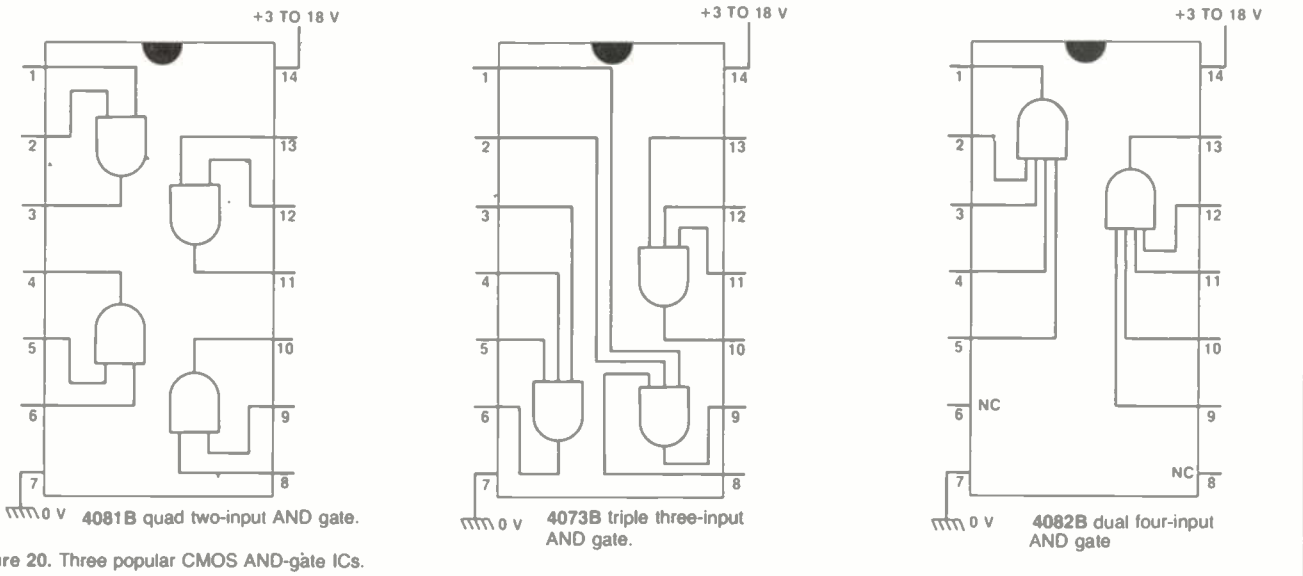


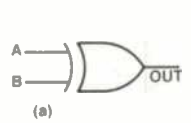
Figure 20. Three popular CMOS AND-gate ICs.

Figure 20 gives details of three popular CMOS AND gates, the 4081B quad two-input type, the 4073B triple three-input type, and the 4082B dual four-input type.

Figure 21 gives details of five popular CMOS NAND gates. The 4011, 4023 and 4012 are quad two-input, triple three-input and dual four-input types respectively. The 4068B is an eight-input device with both AND and NAND outputs. The 40107B is a dual 2-input NAND gate, housed in an 8-pin package, with outputs via open-drain n-channel transistors that can (typically) sink 136 mA.

EX-OR and EX-NOR gates

Figure 22a shows the standard symbol of a two-input EX-OR (EXclusive-OR) gate, and Figure 22b shows its truth table. The output of the EX-OR gate goes high only when the two inputs differ. A useful feature of the EX-OR gate is that it can be used as either an inverting or a non-inverting amplifier by wiring or switching one of its inputs either to the positive (logic 1) supply rail (inverting mode) or to ground (non-inverting mode), as shown in Figure 23.



A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	0

(b)

Figure 22. (a) Symbol and (b) truth table of a two-input EX-OR gate.

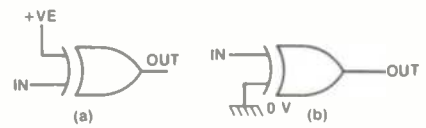


Figure 23. Two-input EX-OR gate connected as (a) inverting and (b) non-inverting amplifier.

Figure 24 shows the symbol and truth table of a two-input EX-NOR gate. This logic element is equivalent to an EX-OR

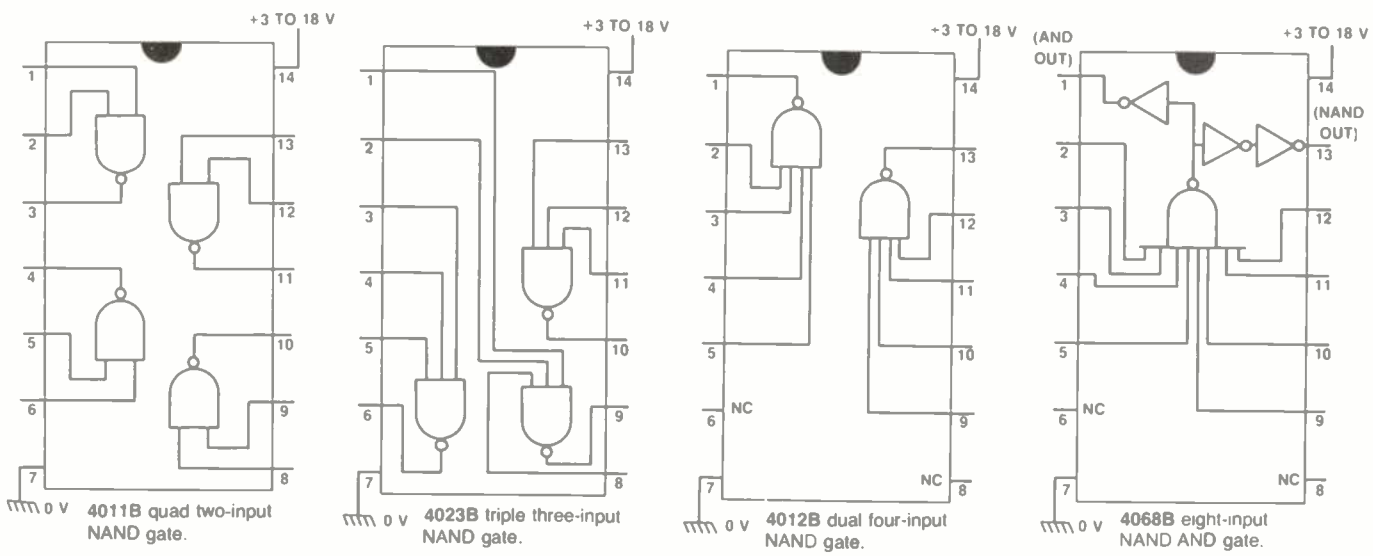


Figure 21. Five popular CMOS NAND-gate ICs.

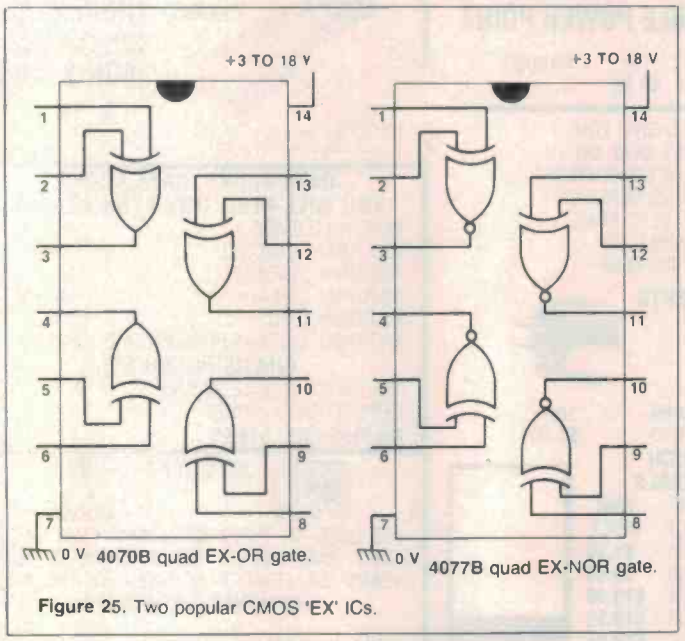


Figure 25. Two popular CMOS 'EX' ICs.

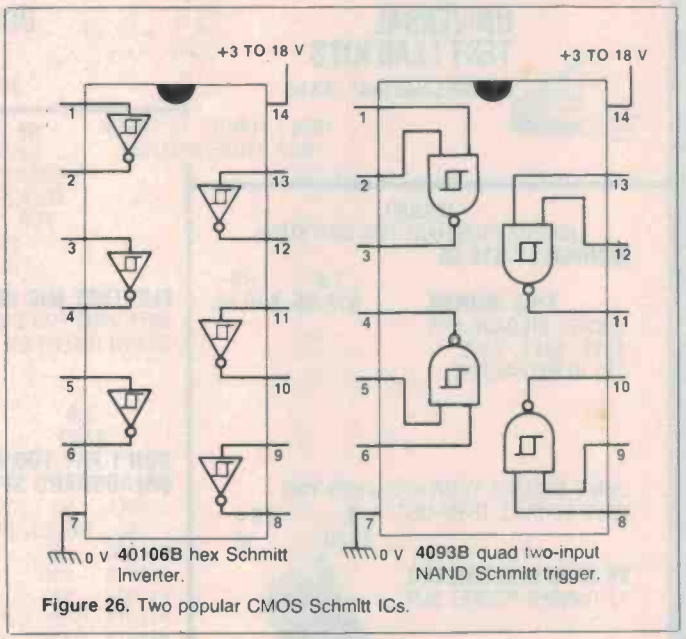


Figure 26. Two popular CMOS Schmitt ICs.

gate with an inverted output. It gives a high output only when both inputs are identical, and is very useful in logic-comparator applications.

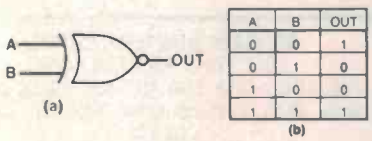
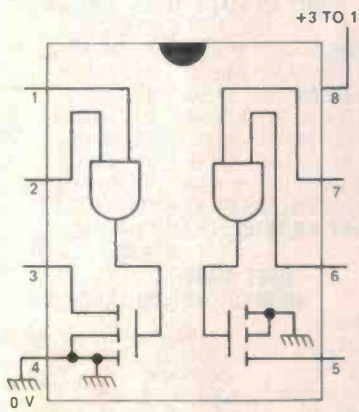


Figure 24. (a) Symbol and (b) truth table of a two-input EX-NOR gate.

Figure 25 shows details of the two best known CMOS 'EX' devices, the 4070 quad EX-OR gate and the 4077 quad EX-NOR gate.



40107B dual two-input NAND buffer/driver.

Special inverters and gates

CMOS inverters and gates are generally intended to be driven by logic signals that are in either the fully-high (logic 1) or fully-low (logic 0) states. If inputs are allowed to linger between these two states for more than a few microseconds, there is a danger that the inverter/gate will become unstable and act as a high-frequency oscillator, thereby generating false output signals. Consequently, if 'slow' signals are present at one or more of the inputs of a CMOS logic system, these signals must be 'conditioned' (given fast rise and fall times) before being applied to the actual logic circuitry.

The most useful conditioning element is the Schmitt trigger, and Figure 26 gives details of two popular CMOS Schmitt ICs, the 40106B hex Schmitt inverter and the 4093B quad two-input NAND Schmitt trigger.

Most CMOS logic ICs are dedicated devices; e.g: the 4082B is a dual four-input AND gate, and can be used as nothing *but* an AND gate. One very useful exception to this is the 4048B multifunction 'programmable' eight-input gate, which has the functional diagram and outline shown in Figure 27. This IC has two groups of four input pins, plus an EXPANSION input pin, and is provided with four control (K) pins which enable the user to select the mode of logic operation.

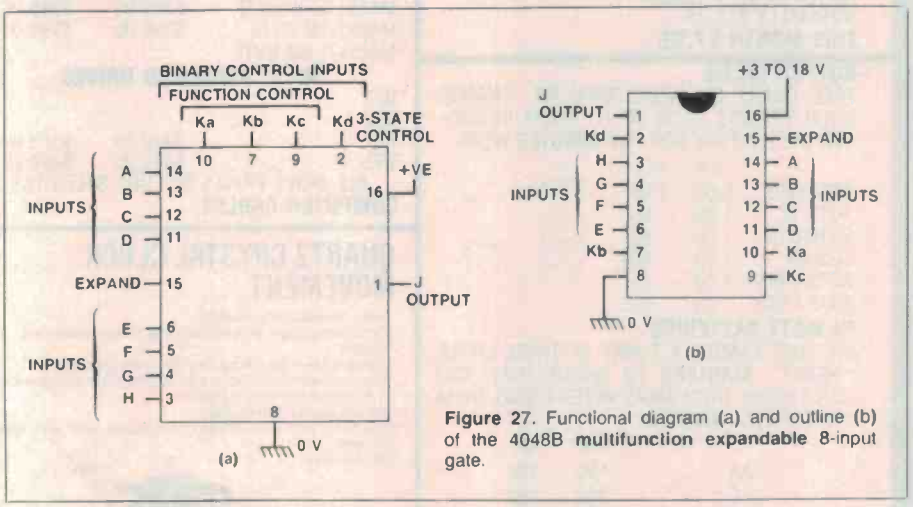


Figure 27. Functional diagram (a) and outline (b) of the 4048B **multifunction expandable** 8-input gate.

Control input Kd (pin 2) enables the user to select either normal (pin 2 high) or high-impedance tri-state (pin 2 low) output operation. The remaining three binary control inputs — Ka, Kb and Kc — enable one of eight different logic functions to be selected, as shown by the table of Figure 28a, which also shows how to connect unwanted inputs in each mode of operation. ▶

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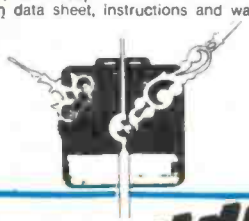

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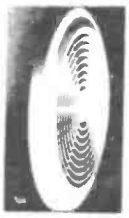

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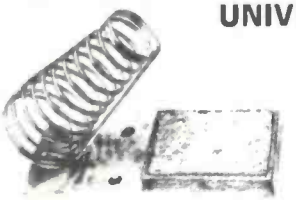

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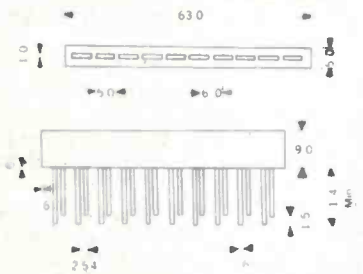

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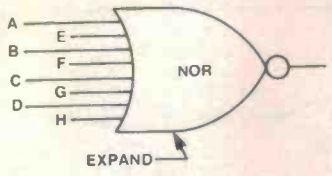
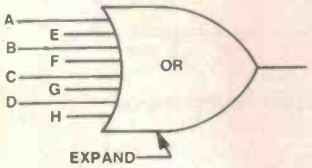
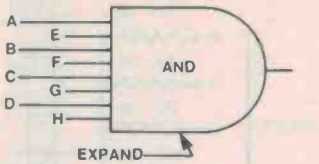
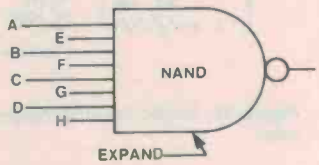


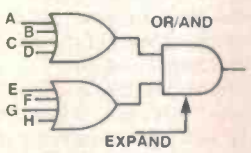


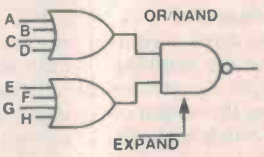
OUTPUT FUNCTION	Ka	Kb	Kc	UNUSED INPUTS
NOR	0	0	0	0
OR	0	0	1	0
OR/AND	0	1	0	0
OR/NAND	0	1	1	0
AND	1	0	0	1
NAND	1	0	1	1
AND/NOR	1	1	0	1
AND/OR	1	1	1	1

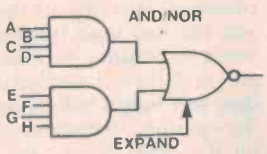
Kd = 1 for normal action
= 0 for high-Z outputs
Expand input = 0











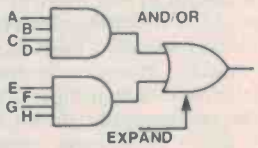


Figure 28. Function table and the eight basic logic configurations of the 4048B multifunction expandable eight-input gate.

Thus, to make the 4048B act as a normal six-input OR gate, connect the two unwanted inputs to ground (logic 0), and control pins Ka and Kb to ground and pins Kc and Kd to the positive supply rail. The EXPAND input (pin 15) is normally tied to ground.

Eight different logic functions are available from the 4048B, as shown in Figure 28b. Note that operation in the AND, OR, NAND and NOR modes is quite conventional, but that operation in the remaining four modes (OR/AND, OR/NAND, AND/OR and AND/NOR) is less self-evident.

In the latter cases the inputs are broken into two groups of four, with each group providing the first part of the logic function, but with the pair of groups providing the second part of the logic function. Thus, in the OR/AND mode, the circuit gives a high output only if at least one input is present in the A to D group at the same time as at least one input is present in the E to H group.

The EXPAND input terminal of the 4048B enables ICs to be cascaded so that, for example, two ICs can be made to act as a 16-input gate by feeding the output of one IC into the EXPAND terminal of the other.

Note when using expanded logic that the input logic feeding the EXPAND terminal is not necessarily the same as the overall logic that is required: Thus, an OR EXPAND input is needed for expanded NOR or OR operation, a NAND EXPAND for AND and NAND operation, a NOR EXPAND for OR/AND or OR/NAND operation, and an AND EXPAND for AND/OR or AND/NOR operation.

Majority logic

To conclude, let's take a brief look at a little-known logic system known as *majority logic*, in which the logic unit has an odd number of inputs (3, 5, 7, etc) and gives an output only when the *majority* of inputs (2, 3, 4, etc) are high, irrespective of WHICH inputs are active. This type of logic is useful in some special applications, such as in voting machines and semi-intelligent alarms and robotic devices in which, for example, an alarm bell may sound only if at least two or three detectors indicate a 'fault' condition, or a robot may move only if there is more stimulus to move than there is to stand still.

The best known CMOS majority logic IC is the 4530B dual five-bit unit (Fig 29), each half of which contains a five-input majority logic element with its output feeding to one input of an EX-NOR gate that has its other input (W) externally available, enabling it to be wired as either an inverting or non-inverting stage. Thus, when 'W' is tied to logic 1, the EX-NOR stage gives non-inverting action and the output of the element goes high only when the majority of inputs are high: when 'W' is tied to logic 0, the EX-NOR stage gives an inverting action and the output of the element goes high when the majority of inputs are low.

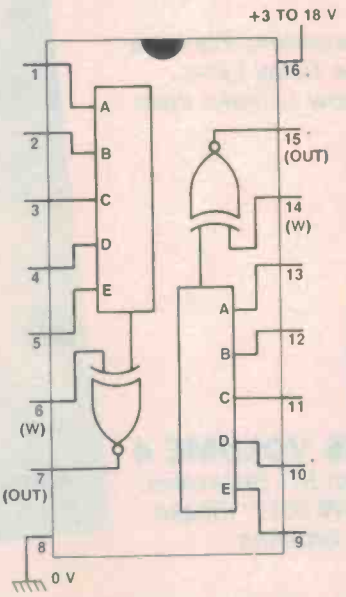


Figure 29. Details of the 4530B dual five-bit majority-logic gate.

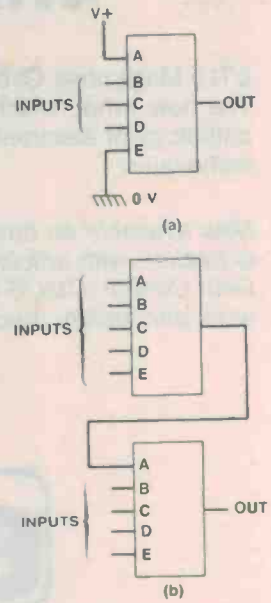


Figure 30. The number of effective inputs of a majority-logic circuit can easily be (a) decreased or (b) increased.

The effective number of inputs of a 4530B can be reduced by wiring half of the unwanted inputs to logic 1 and the other half to logic 0 (Figure 30a). The effective number of inputs can be increased by cascading elements, as shown in Figure 30b. ▶

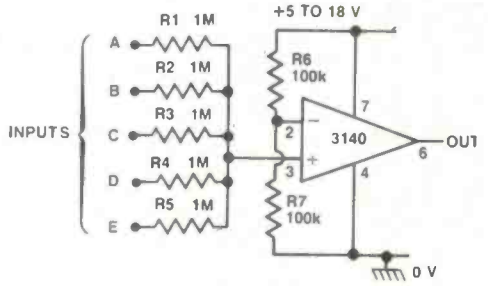


Figure 31. Simple five-input op-amp majority-logic gate.

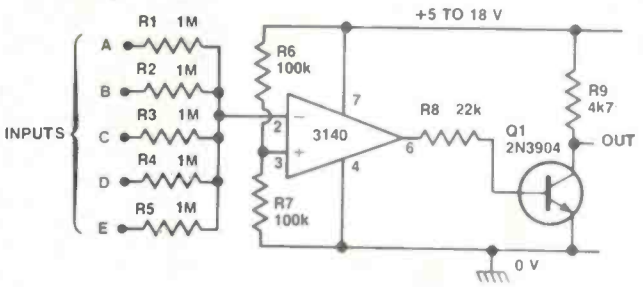


Figure 32. Compound five-input op-amp majority-logic gate.

taking the output of one element to one of the inputs of the following element.

The 4530B is actually a fairly hard to find IC. Fortunately, however, majority logic can easily be created by using a CA3140 op-amp in the configuration shown in Figure 31, which shows a five-input circuit. Here, the op-amp functions as a voltage comparator, with potential divider R6-R7 applying half-supply volts to pin 2 of the op-amp, and the five input resistors (which are each connected to either ground or the supply rail) form a potential divider that applies a fraction of the supply voltage to pin 3.

Suppose that two input resistors are connected to logic 0 and three resistors go to logic 1. The three logic 1 resistors have a combined (paralleled) impedance of 333k, and the two logic 0 resistors have a combined impedance of 500k, so the resulting potential-divider voltage on pin 3 is greater than half-supply volts, causing the output of the op-amp comparator to switch high. If, on the other hand, only two of the five inputs are taken to logic 1, the resulting pin 3 voltage is below half-supply value and the op-amp output is switched low. The circuit thus gives 'majority-logic' action.

When 5% resistors are used the Figure 31 circuit can be given any number of inputs up to a maximum of eleven by simply adding one more 1M resistor for each new input. The output of the circuit switches fully to zero volts when the output is low, but only rises to within a couple of volts of the supply rail value when the output is high.

In most applications this defect is of little importance; it does, however, mean that elements cannot be cascaded to increase the effective total number of inputs. This defect can be overcome by using the alternative 'compound' configuration of Figure 32, in which the output is inverted and level-shifted by Q1 and the inputs to the op-amp are transposed. The output of this circuit switches to within 50 mV of either supply rail, enabling units to be cascaded without limit. ●

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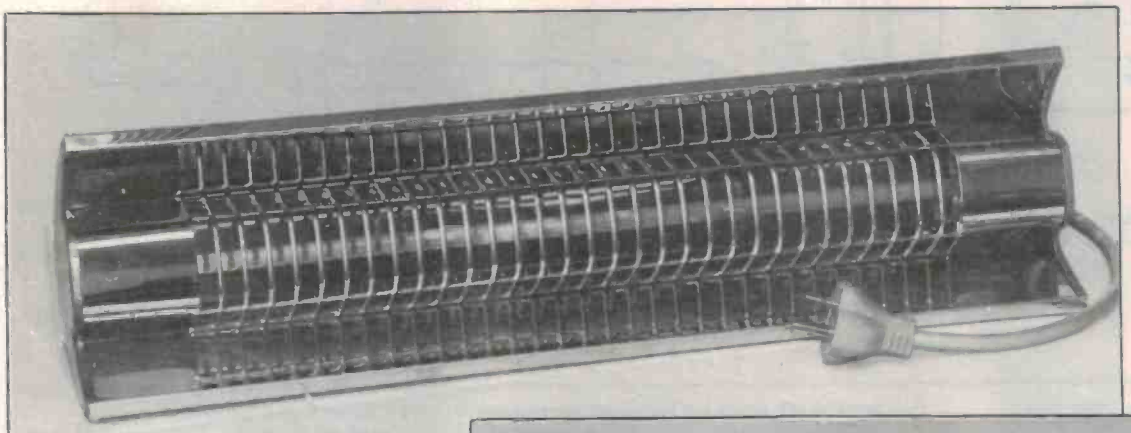
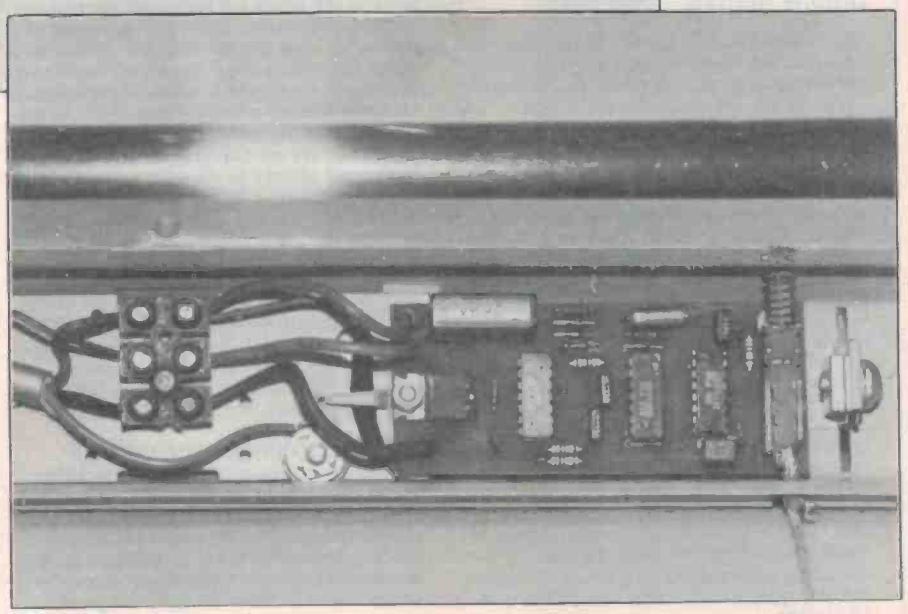
. . . more books on pages 158-159

Bathroom strip heater time-out

Ian Thomas





Ever left your bathroom strip heater on all day! Sure boosts the electricity bill! This simple project automatically turns off the heater after allowing you enough time for morning ablutions. Just pull the switch cord when you walk in the bathroom of a morning and the project does the rest. No bathroom strip heater? — no worries, this shows you how to build one in a commonly available model.

IT IS PROBABLY not everyone's misfortune to return from six week's holiday in Bhutan or Tenerife to find the bathroom strip heater has been left on, but even a one day lapse of memory can cost about 50c. Even more important though, is the risk of fire due to an unattended heater. A nice answer to this problem seemed to be to incorporate some form of simple timer into the pull-on/pull-off switch used to control the heater.

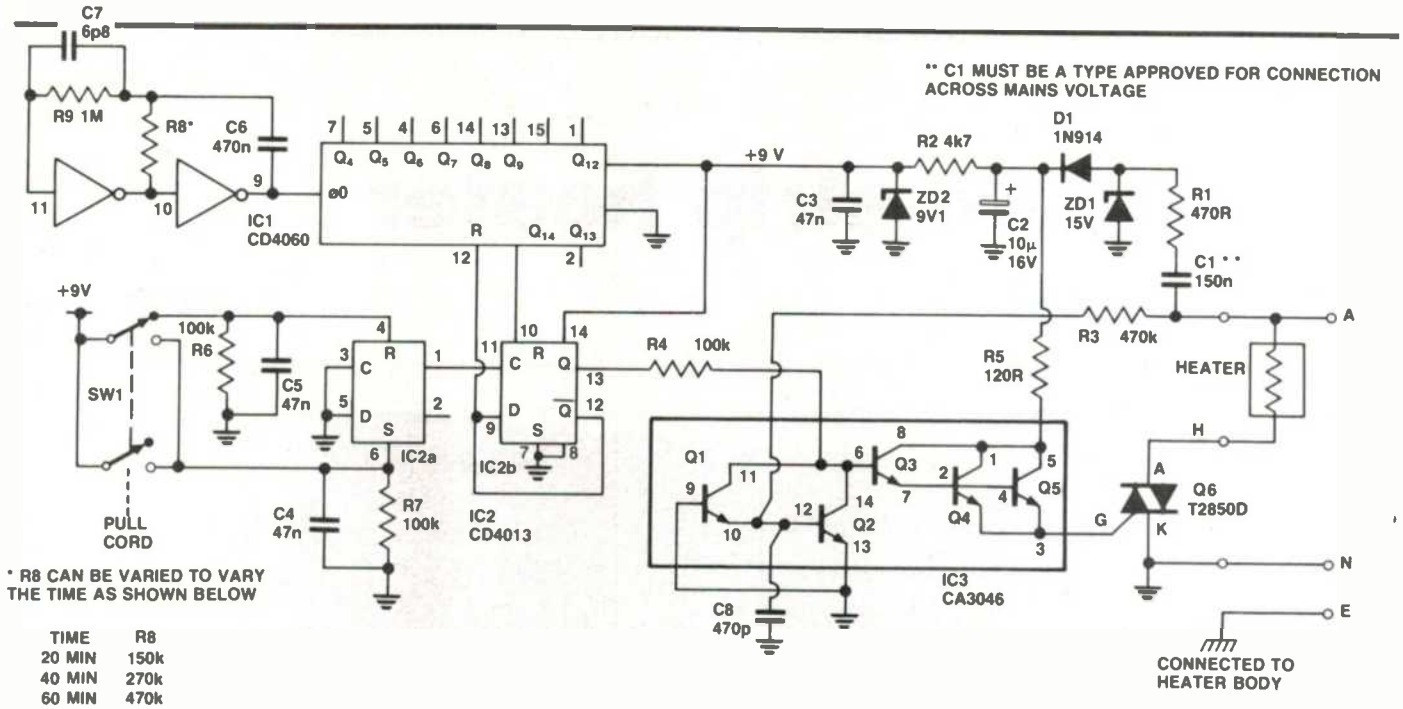
Giving the matter a little thought it seemed that the switch pull cord should work exactly as normal, except that whenever the heater was turned on a timer was started which would shut it off again after 30 to 40 minutes (and if anyone was in the bathroom for longer than that then the heater turning off would be a timely reminder). Also, if the timer needed to be restarted then simply turning the heater off then on again would do the trick.

Design

A quick survey of bathroom strip heaters available from electrical supply houses showed a considerable variety available with power ratings of between 750 and 2400 Watts. As I wished to be warmed rather than crisped, I chose a 'Rayflow' model 22/13 (750 Watts) and a model 22/15 (1100 Watts) to construct prototypes. Both are bare wall mounted single bar heaters with no power cord or switch and hence nothing to have to throw away when I started modifying.

Once the power rating of the heaters was chosen, a suitable triac was selected to handle the necessary current (3.1 A for the smaller heater and 4.6 A for the larger). The RCA T2850 series of triacs seemed to fill the bill exactly as they can handle up to 8 A RMS, given adequate heat sinking, and are reasonably cheap. Another great advantage is that the T2850 comes in a standard T0-220 outline with the mounting tab electrically isolated from the power. This makes things a lot safer as the heater electronics is switching lethal voltages; a fact which must *NEVER* be forgotten. The 'D' version of the triac range can block up to 400 V and is the one to use for 240 Vac applications.

From the data sheets, the gate current needed to turn the triac on reliably is about 60 mA under all conditions, or say 100 mA to be safe. This made the control power ▶



HOW IT WORKS — ETI-275

The heater-timer can be divided up into four sections: the power supply, the triac circuit, the pull-on:pull-off circuit and the timer itself. Each section will be described in turn.

THE POWER SUPPLY:

DC power for the electronics is provided from the mains input through capacitor C1, diodes ZD1 and D1, and the electrolytic capacitor C2. When the active mains input is swinging negative diode, D1 is reverse biased and ZD1 is turned on. Capacitor C1 is therefore charged up to the peak negative voltage of the mains (about −315 volts). When the mains start to swing positive ZD1 turns off and D1 turns on pumping the charge stored in C1 into C2. During this part of the cycle C1 and C2 act as a potential divider to reduce the mains down to a safe level. When C2 has enough charge zener diode ZD1 breaks down to dump any excess charge to ground. R1 is in series with C1 to protect the zener ZD1 from any transients on the mains input as C1 looks like a short circuit to any spikes or steps in mains input. A second stage of regulation is provided by R2, ZD3 and C3 to give a stable supply for the timer and pull-on:pull-off circuits.

THE TRIAC DRIVE CIRCUIT

As described in the design section the triac Q6 requires a short pulse of about 100 mA just after the mains voltage passes through zero volts. This function is performed by transistors Q1 and Q2 which are part of the IC transistor array IC3. Mains voltage is applied to the emitter of Q1 and the base of Q2 through R3. When the mains voltage is positive Q2 is turned on and the common collectors of Q1 and Q2 are clamped to ground. When the mains swings negative Q1 acts as a common base stage and turns on, once again clamping the two collectors to ground. As the input voltage passes through zero volts both Q1 and Q2 are momentarily off and their collectors are allowed to rise to the control voltage determined by IC2b. If pin 1 of IC2 is high then, just after the mains voltage passes through zero, a positive pulse is applied to the base of Q3 which acts as an emitter follower. Transistors Q4 and Q5 give more current gain and R5 sets the final level of the current pulse to be applied to the gate of the triac. If, however, pin 1 of IC2 is low it makes no difference what happens to Q1 and Q2 as their collectors always stay at zero volts and no triac trigger pulses are produced.

THE PULL-ON:PULL-OFF CIRCUIT

This function is performed by a break-before-make switch (see construction for details) where two sets of contacts are used for better reliability together with a dual CMOS type D flip flop. One half of the IC is used as a simple set-reset flip-flop to "debounce" the switch contacts and its D and C inputs are grounded and not used. The Set and Reset inputs (pins 4 and 6) both are grounded through 100k and 47nF and are connected to the switch changeover contacts. The switch common is connected to the positive rail so that when the switch is operated only one positive edge appears at the Q output pin 13. The capacitors C4 and C5 serve to suppress any transients that may be coupled over from the mains side of the system as the pull-downs are a rather high impedance.

The second half of IC2 is connected as a toggling flip-flop and its Q output is connected to its D input. Every time a positive edge is generated by the switch debounce flip-flop it changes the state of the control flip-flop and enables the triac or shuts it off. At the same time the Q output also enables or disables the timer.

THE TIMER CIRCUIT

The timing function is performed by a CMOS oscillator-timer IC1 which is a CD4060. This IC consists of an inhibitable oscillator circuit which only needs a few external resistors and capacitors, together with a 2^{14} divider circuit. This means the oscillator must produce 2^{13} or 8192 pulses before the last stage, Q14, goes positive. If we want about a 30 minute delay then the oscillator output period should be 30X60/8192 or about 0.22 seconds. This period is set by R8 and C6 which together have a time constant of about 0.13 second (the oscillator gives an output pulse roughly every two time constants). R9 serves to limit the input current to the CMOS input pin 11 and C7 acts as a speed-up capacitor. When the reset pin 12 is taken high the oscillator circuit is inhibited and all fourteen divider stages are set low. Therefore when the control flip-flop Q output is low and the heater is off then the Q output is high and inhibits and resets the timer. As soon as the heater is turned on the timer is released and after about 35 minutes (measured) the timer Q14 goes positive and resets the control flip-flop. As soon as the control flip-flop is reset it resets the timer and the whole circuit returns to its idle state.

needed to operate the triac quite appreciable by itself, ignoring any power needed to operate the timer circuitry. This brought me head on to the first difficulty. The heaters chosen (and in fact almost all wall mounted heaters) have quite narrow bodies which mount flush to the wall and there simply isn't enough room to mount any readily available power transformer capable of handling the gate power requirements.

Problem!

However, all was not lost as triacs need only be pulsed on once every half cycle of the 50 Hz mains, or evey 10 milliseconds. Also, the pulses can be very short (10 µs is heaps), provided the pulse is applied at exactly the right time. This means our current needs are reduced by a factor of $10^{-6}/10^{-3}$, or 1000 times — much more reasonable! There are ICs available to do this pulse generation and timing (such as the RCA CA3058 or CA3079) but they are powered from the 240 V mains through a resistor which has to drop several watts itself. This amount of power in one component makes for hot, and therefore unreliable, electronics. (As an aside, the reliability of an electronic device is halved for about every 10° C temperature rise, so if our timer operates at 70° C rather than

25° C then it will probably fail 25 times sooner!)

Since the average total current drain of the timer and control circuitry can be reduced to below about 10 mA, then capacitive-divider type power supplies seem to be ideal. These use two capacitors as a potential divider to give a (comparatively) low impedance low voltage ac supply. When combined with a couple of diodes (see 'How It Works') you get a low voltage dc output. For low current applications this is a cheap, compact and safe dc source provided the smaller (higher impedance) capacitor is connected to the *active* mains input and is a type approved for continuous connection across the 240 Vac supply (see 'Parts List'). This combination of triac pulse triggering and the use of low power CMOS timing circuits solved the transformer problem but left me with the problem of generating the trigger pulses for the triac without wasting power.

As we have a triac whose gate must be taken positive with regard to terminal 2 to turn it on, then what is needed is a series of positive-going pulses about 10 µs long just after the mains voltage has gone through zero volts. If all the effects of triac holding current are allowed for then the pulse should be present until about 30 µs after the mains passes zero volts to ensure the triac stays on.

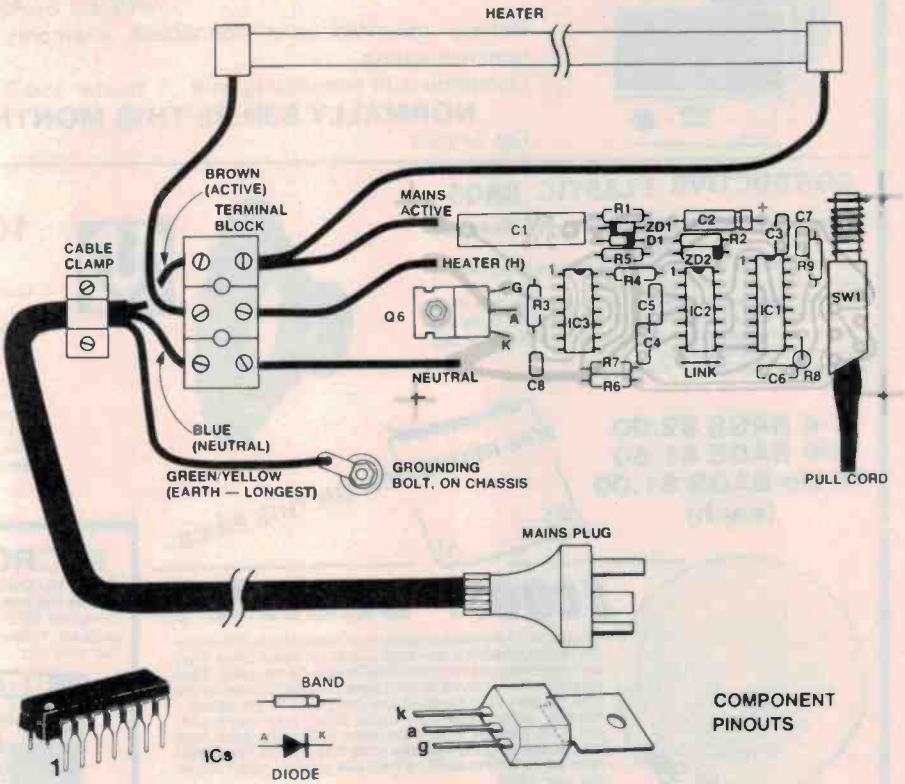
One very cheap integrated transistor array such as a CA3046 can be connected to achieve exactly the required functions, together with three resistors and one capacitor (once again, see 'How It Works'). The circuit also gives a high impedance control input to gate the trigger pulses. The toggling pull-on/pull-off operation with timer reset and control area are also described in detail in 'How It Works' and require only two cheap CMOS ICs to do everything needed.

Construction

As the heater timer is controlling 240 V and the intended environment is often damp and steamy it is most strongly recommended that the timer be constructed on the printed circuit board designed for the project and available from several suppliers, or from a pc board made from the artwork reproduced elsewhere here.

A rough and ready approach with mains power will give spectacular and perhaps permanent results (and we need all the readers we can get!), so unless you really know what you're doing it's safer to stick exactly to the instructions. I built two prototypes using the Rayflow heaters mentioned in the design section as they had metal bodies where I mounted the electronics. This gives a nice, safe *earthed* box which is also used as a heatsink for the triac (which must drop between three and five Watts when the heater is on).

Before assembling the pc board, the first thing to do is use the blank board as a template to mark and drill the heater body. Carefully locate the board so that the end where the triac is mounted covers 8-10 mm of the centre reinforcing of the heater body (which acts as the triac heatsink). Make sure that the long axis of the blank board is exactly centred on the heater body axis and mark where the triac mounting hole is on the heater body.



Remove the blank board and centre-punch and drill a 9/64" (3.6 mm) hole through both the centre reinforcing and the front of the heater body. Be careful not to damage the reflector.

Next, enlarge the hole in the front of the heater body to ¼" (6.4 mm) using a larger drill. Insert a 3.5 mm (or if you still have some, a 4BA) by 12 mm machine screw through the larger hole in the heater body front so the free end of the screw protrudes through the centre reinforcing and tightens with a suitable nut. Make sure there are no burrs in the holes as the screw acts to carry away the excess heat from the triac and good thermal contact is essential.

The free end of the screw is the mounting post for the triac end of the pc board. Reinsert the blank pc board over its new mounting post and mark off the mounting hole for the other end of the board and the point where the switch cord will go through the bottom of heater body. Once again, make sure the long axis of the board is exactly parallel to the long axis of the heater body. Drill out the second mounting point to 9/64" (3.6 mm) also.

Cut a hole for the pull cord about 4 mm wide by 6 mm long to ensure the cord doesn't foul when the unit is finally assembled. This just about completes the tedious mechanical work and now the interesting electronics part can begin.

Start assembling the pc board with all the smaller components first. Make sure that the ICs are oriented correctly (to reverse is to destroy!) and most important of all, see that diodes D1 and D2 are correctly inserted. When assembling the triac be sure to

PARTS LIST — ETI-275

Resistors ..... all ¼W, 5%
- R1 ..... 470R
- R2 ..... 4k7
- R3 ..... 470k
- R5 ..... 120R
- R4, 6, 7 ..... 100k
- R8 ..... (See circuit diagram)
- R9 ..... 1M

Capacitors
- C1 ..... 150n/250 Vac (e.g: AEE type PME271 M or similar).
- C2 ..... 10µ/16 V axial electro.
- C3, 4, 5 ..... 47n ceramic or ploy.
- C6 ..... 470n/63 V, 10% Wima, type PR-21 or similar.
- C7 ..... 6p8
- C8 ..... 470p

Semiconductors
- IC1 ..... 4060B
- IC2 ..... 4013B
- IC3 ..... CA3046
- Q6 ..... T2850D
- D1 ..... 1N914
- ZD1 ..... 15 V/1 W zener
- ZD2 ..... 9V1/400 mW zener

Miscellaneous
- SW1 ..... 4-pole changeover pushbutton switch (modified), Jeanrenaud type TJ (from STC-Cannon).
- Heater ..... "Rayflow" model 22/13 (750 W) or model 22/15 (1100 W), either may be used (or similar type).

ETI-275 pc board; 3-way terminal block, mains-rated hookup wire (24 x 0.2 mm); nuts, bolts, etc.

Price estimate: $25-$28 (less heater)

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Jaycar has made a scoop purchase of heavy duty conductive plastic bags with inbuilt zipper closer.

Each bag measures a generous 280 high x 205 wide. They will accommodate complete S-100 boards, RAM cards etc. You can store your precious ICs in them safely. (The bag would hold hundreds of ICs).

Quantities strictly limited. First in first served.

Cat. ZB-9990

1-4 BAGS $2.00
5-9 BAGS $1.50
10 Up BAGS $1.00 (each)

10" ELECTRIC GUITAR SPEAKER

Quality Pioneer brand - check the specs! Check the price!! HURRY

Impedance	8 ohms
Voice Coil dia.	1½"
Power Rating	60W (RMS)
Resonant Frequency	80Hz
Sensitivity	98(dB/W)
Response	80Hz - 7,000Hz
Total Flux	61,100 Maxwell
Flux Density	8,300 Gauss
Net Weight	1,540 grams

ONLY $29.95

SCOOP!

8" CEILING GRILLES

- Will they ever be this cheap again?

Once again - a massive scoop purchase with a difference. We have purchased a very large quantity of 'reject' grilles. They are rejects because they have small flaws in the mouldings. Most people however cannot pick the flaws if allowed to examine the grille. Imagine what the flaws look like *9 feet up* on the ceiling! Naturally we are offering a massive saving over normal units which we also sell. Exactly the same units (sans flaws) have been sold throughout Australia in the 10's of 000's. The perfect ones sell for around $2.95 - at least one company sells them for well over $3.00.

Cat. AX-3560

WHAT PRICE US?

1-4 UNITS $1.50
5-19 UNITS $1.25
20-49 UNITS $1.15
50 + UNITS 99¢

PRICES INCLUDE TAX

P.A. INSTALLERS - GO FOR IT!

TAKES STANDARD 8" SPEAKERS

MICROBEE KEYBOARD

Full 60 key QWERTY Computer keyboard exactly the same type as has been used up to now with the famous MicroBee Computer. SPST keys. Complete with mounting plate, all key caps etc. Fully assembled - incredible value.

Cat. XA-5500

ONLY $29.95

240V CASSETTE HEAD DEMAGNETISER

We have made a massive scoop purchase of this popular item. **Normally $8.50 each**

$5.95 - SAVE $2.55

Cat. AC-1600

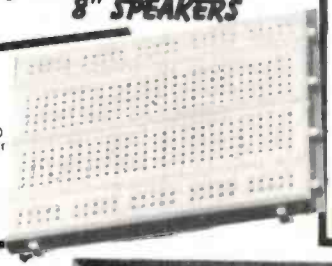
MINI BREADBOARD

BARGAIN TIME

390 HOLES, perfect for small projects. Measures 80 x 60 mm. Several units can be made to lock together for larger breadboard configurations. Sel-adhesive back.

NORMALLY $6.95

Cat. PB-8808 **$4.95 SAVE $2**



NEW!!!

4½ DIGIT LCD DPM 60

★ 200mV fsd ★ Digital Hold ★ Bandgap Reference ★ 10uV Resolution ★

A new 4½ digit LCD DPM offering levels of performance, low current consumption and compact size never previously available. The DPM 60 features auto-zero, auto-polarity, a logic switched 200mV or 2V fsd, digital hold, programmable decimal points and a 1mA current consumption. Automatic low battery indication and 'continuity' flags are built into the 10mm 4½ digit display. The DPM-60 can be readily scaled by the user to indicate many different units, amps, volts, ohms etc. Supplied complete with fixing bezel, clips and connector. The DPM 60 will suit many applications calling for low-cost, high accuracy measurements in portable or bench instruments.

Cat. QP-5520

SPECIFICATIONS:
- ★ Accuracy 0.01% ± 1 digit
- ★ Linearity ± 1 digit
- ★ Sample/Sec - 1.6
- ★ Temperature stability - 50ppm/°C typical
- ★ Temperature range - 0-35°C
- ★ Supply voltage - 7.5 to 15V
- ★ Supply current - 1mA typical
- ★ Maximum DC input voltage - ±20V

LESS $10 JUNE
$79.95
Usually $89.95

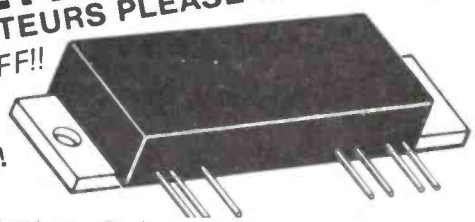
UHF AMPLIFIER SENSATION

15W at 12V 420 MHz

AMATEURS PLEASE NOTE!

50% OFF!!

SAVE $20!!



Jaycar has purchased a quantity of genuine Brand New MOTOROLA Brand MHW-710-1 UHF Power Amplifier modules. These units are designed for industrial and commercial FM transmitters!

The unit (pictured) is a rugged, tuned train of RF Power Amplifier transistors featuring thin film gold metal metallization, laser trimmed Nichrome resistors and MOS capacitors. The MHW-710-1 bolts to any flat surface (metal) to assist heat dissipation.

~~$39.95~~

Includes FREE amateur TV transmitter circuit and full data on device!!

ONLY $19.95

Low Cost DATA CASSETTE Player

- Mains or battery operated
- Special instructions for loading instructions into computer
- Tape counter - A MUST!
- Works as audio recorder/player as well
- Inbuilt condenser microphone
- LED recording indicator!

Cat. XC-4905

STAGGERING VALUE!!

ONLY $39.95

JUNE ONLY SAVE 15%
ONLY $84.50

"JET PHONE" ADAPTOR - NEW
- IDEAL FOR AIR TRAVELLERS!!

How many times do you travel by air? If you are a regular traveller in economy, you will be undoubtedly familiar with the plastic 'pneumatic' type of stereo headphones. Well, we think that they are hopeless!!
They are uncomfortable (in our opinion) and unless you get a good fit, the sound quality is poor. Wouldn't it be nice to be able to use your OWN high quality headphones in flight?

NOW YOU CAN!!

The Jaycar AA-2040 JET PHONE ADAPTOR plugs into the two air sockets on the armrest. You then plug your headphones into the adaptor for comfortable HI FI sound!!

BRILLIANT AND INEXPENSIVE!!

ONLY **$8.95**

REGULATED POWER SUPPLIES (3rd Edition)

The newest, most comprehensive discussion of internal architecture and operation of the latest solid-state regulators. Thoroughly explains when regulated supplies are needed and how to incorporate them into your design projects. Discusses modern, practical circuitry including linear and switching circuits and late ICs. A valuable asset for any technician or engineer involved in servicing or design.
424 Pages. 5½ x 8½, soft.
Cat. BS-0526 ..... $27.95

NEW!!!

HEART RATE MONITOR

Not a kit. Built, tested and guaranteed.
This fully self-contained unit enables you to monitor your pulse rate - anywhere!!
The unit features large, easy to read LED display and comfortable finger grip pulse sensor.
An exclusive feature is the bracket that enables you to mount the unit to tubular objects such as a bike (or exercise bike), weight training equipment etc.
NOW you can monitor your heartbeat accurately and easily while *in the middle* of exercise!!
The comprehensive booklet gives you explicit instructions on use of the monitor as well as mounting guidelines.
Once again this is a beautifully presented piece of equipment. Included, are mounting bracket, vinyl case, instructions and 9V battery.
Cat. QM-6110

MORAY FLOW SENSORS BACK - BACK IN STOCK!!!

The original unit as used in the EA Car Computer (Aug '82)
Due to pressure of demand another batch of genuine MORAY fuel flow sensors has been acquired. Despite devaluation of the Australian $ and inflation, we can STILL bring them to you at our August 1982 price of $59!!
Each unit is individually calibrated and comes complete with data.

Cat. XC-2020 ..... $59
"T" piece for fuel bypass systems.
Cat. XC-2021 ..... $3.95

SMOKE DETECTORS BACK!!

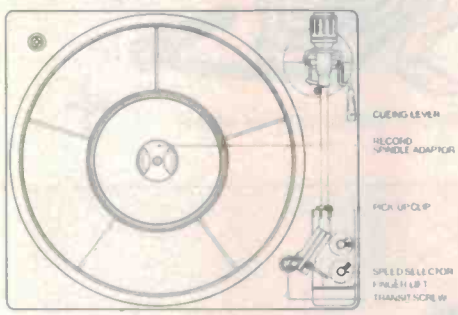
BARGAIN OF THE CENTURY

Once again we have made a scoop purchase of ionisation chamber type smoke detectors.
When we had this product before we sold many thousands at our ridiculously low prices. We sold out of course but NOW THEY'RE BACK!!
The smoke detector is completely self-contained, is round and measures a compact 115mm diameter and 40mm deep. Fixing screws and masonry plugs are provided along with 9V battery and very comprehensive instruction manual.
The "Smoke Sentry" once sold for $49 and frankly was a flop at that price. Despite the fact that every home should have at least one, people considered that their children and their own lives were not worth that amount.
But now you have NO EXCUSE! Once again Jaycar has made a MASSIVE SCOOP PURCHASE of SMOKE DETECTORS below importers COST! We pass the savings on to you!
If you missed out before HURRY this time. Don't be disappointed!!
Cat. LA-5090

1-9 Pcs
$19.95
10+
$17.95

MASSIVE PRICE BREAKTHROUGH!
ELECTRONIC BELT DRIVE TURNTABLE
BSR QUALITY

Jaycar has made a sensational purchase of Belt Drive Turntables - BELOW Manufacturers Cost!!
Because of our buy we can pass them on to you at a **MASSIVE SAVING.**
The Turntables are made in England by B.S.R. They are unmounted and suitable for Disco Consoles, 3-in-1's etc. They are also ideal as replacements for existing 3-in-1 sets. (See specifications).
But there is an aspect that is really amazing! You can work the Turntable from 9-12V DC. This means that you can run the unit from a car or truck!! (The AA0292 model can of course run on 240V mains).
The Turntable features quality Belt Drive operation, lightweight Transcription type arm, Cueing facility and Stereo Ceramic cartridge with Diamond Stylus.
The platter has calibration markings to check speed. A simple neon on 240V will "strobe" to the markings).
Whilst the 33 & 45 rpm speed has been accurately set in the factory, you have the facility to make pitch adjustments underneath the turntable.
The DC Motor Drive (as used in the best turntables) is electronically controlled!!
Each unit comes with complete instructions.
Quantity limited! You will have to hurry to avoid disappointment.



SPECIFICATIONS:

- Dimensions 330(W) x 285(D) x 60(H)mm overall
- Platter diameter 280mm
- 2 speed - 33 & 45 rpm (internally adjustable)
- Pick-up arm counterbalanced type with cueing facility
- Pick-up ceramic (stereo) with diamond stylus
- Turntable operation - auto stop, will return to rest automatically. Turntable chassis is sprung on all corners with transit screws & clips
- Output stereo RCA sockets underneath unit
- Weight 1.5kg

Check the price! Cat. AA-0290
(Requires 9-12V DC @ 500mA)
ONLY $29.95
240V version - (Includes 12V 500mA adaptor)
Cat. AA-0292 **ONLY $39.95**
(Due to the weight of the unit post and packing is $5 NOT $4.50).

Jaycar Incorporating **ELECTRONIC AGENCIES**

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NUMBER 1 FOR KITS

POST AND PACKING CHARGES
$5 - $9.99 ($1.50) $10 - $24.99 ($3.20)
$25 - $49.99 ($4.50) $50 - $99.99 ($6.50)
$100 - $198 ($8.00) Over $199 ($10)
"Free INSURANCE for Road & Registered Post over $200"
All heavy or bulky items (over 20kg.) sent Comet Road Freight $12.00 anywhere in Australia.

SHOP HOURS CARLINGFORD, CONCORD & HURSTVILLE
Mon - Fri 9am - 5.30pm: Sat - 9am - 12pm: Thurs night 8.30pm (Not Concord)
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Mon - Fri 8.30am - 5.30pm. Sat - 8.30am - 12pm: Thurs night 8.30pm
MAIL ORDERS AND CORRESPONDENCE: P.O. Box 185, Concord, 2137

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bend the leads so the tab mounting hole falls exactly over the hole in the pc board. Do not at this stage attempt to assemble the switch as it has to be modified first.

Insert 240 volt insulated wires into the holes provided and marked (H is heater control out) observing the international colour coding for active (brown) and neutral (blue) as someone else may work on the heater later on and there is no future in building in nasty surprises (especially if the someone is an ETI staff member!)

The pull-on/pull-off switch presented special problems as I couldn't find anything suitable ready-made and had to specially modify a pc-mounting slide switch to do the job. The switch was a Jeanrenaud type TJ, four changeover, break-before-make (essential for contact debouncing), momentary contact switch with no mounting bracket or front pressbutton.

The first thing to do is to cut off the end of the slide that holds the front button. The cut should be made just before the circlip that holds the slide spring but leaves enough material to hold the spring securely. (See the accompanying photo.)

The next step is to *very carefully* cut away two of the four changeover contacts as shown here. The cuts should be made very slowly and carefully with a fine toothed hacksaw blade *AND ONLY THROUGH THE OUTER SWITCH BODY*. Do not cut the inner switch slide or the whole switch will be ruined!

Make four cuts around the four sides of the switch body then gently slide off the end of the outer body and discard it. Two tiny metal balls will drop out as the body is removed — these are the actual sliding contacts and can be thrown away also.

Next, drill a 3/32" (2.4 mm) diameter hole through the end of the switch slide that was exposed when the outer body was removed. The indentation that held the ball contact makes an ideal centre punch mark to start the drill.

The last step is to sew the pull cord through the hole you have just drilled. Don't even begin to think about the possibility of toying with the idea of using wire as the pull cord as a nylon cord gives excellent double insulation for the switch and once again there is mains voltage near the other end of the cord to your hand.

After the cord is attached then the switch is ready for assembly.

Before soldering the switch onto the pc board, screw a ⅜" 4 BA spacer onto the board near where the switch mounts. The screw used should be ¼" long and should have a lockwasher under its head. Then solder the switch in position so the cord is at the end away from the screw and the whole assembly is complete.

Once the switch has been modified and assembled with its mounting post then the heater is ready for final assembly, wiring and test. Thread the pull cord through its hole and mount the assembled pc board on its triac mounting screw and switch spacer. Tighten a nut down firmly over the triac mounting tab as this nut forms part of the triac heatsink. Make sure the pull cord operates freely and doesn't foul the sides of its hole (a little trimming with a small rat-tail file may be needed here). When all the mechanics are finished wiring can begin.

Cut a sufficient length of three-core flex to reach from the power point you intend to use to the terminal block in the heater when it is mounted where you want it. Attach a three-pin plug to one end. Strip back the other end outer insulation for about 100 mm and bare about 40 mm of the earth lead. Pass the flex through one of the knock-outs provided and clamp the end of the outer insulation in the cable clamp provided.

Use all the bared earth conductor to make a really solid connection to the earth terminal on the heater body. This connection is the most important in the whole project so take care! Then cut the active and neutral leads to length and terminate them in the mounting block that comes with the heater.

At this stage it is wise to make sure that the active and neutral leads have not been reversed somewhere. With nothing connected to the terminal block except the mains flex you have just connected (disconnect the two heater element leads) insert the three pin plug into the power outlet you intend to finally use and turn it on.

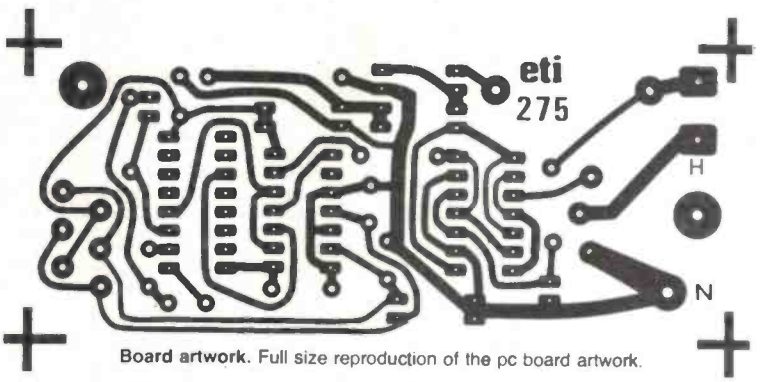
Using an ac voltmeter set to 300 V or 1000 V full-scale, measure the voltage between the active terminal and the earth post. It should be 240 V give or take a bit. The voltage between the neutral and earth should only be a few volts. If the neutral has 240 V then the active and neutral have been reversed somewhere. This problem must be sorted out before the controller is wired in. It may be you wired up the three-pin plug incorrectly or that the electrician wired up the three-pin plug incorrectly or that the electrician wired up the power outlet in error (not unheard of) but the neutral for the electronics *must* go to the supply neutral.

Once you are satisfied as to which is active and which is neutral, wire up the terminal block as shown in the photograph. Mains active is connected to electronics active and one side of the heater element (it doesn't matter which side). The control output from the electronics is connected to the other side of the element using the spare terminal block and you are ready for test.

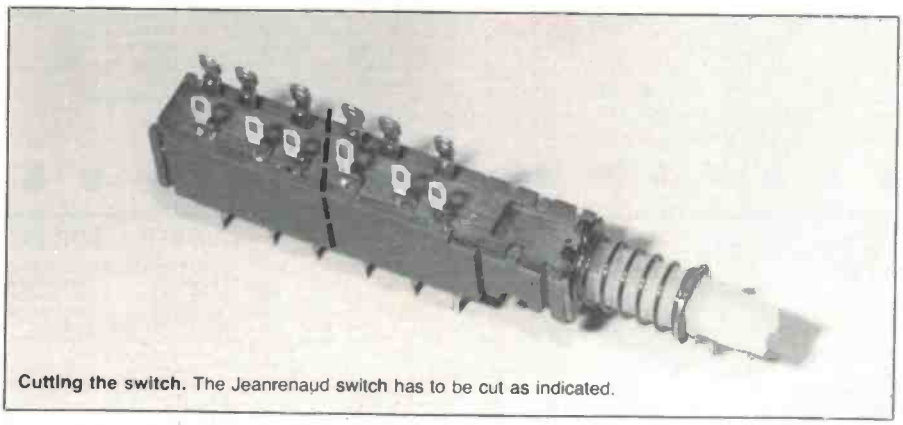
A few quick tests before the heater is wall mounted will make sure that all is well. Plug the heater in and turn it on at the power outlet. *Don't* leave the heater element face down on your bench unless you like fires. Try the pull-on/pull-off switch cord and make sure the heater turns on and off (when the heater element is powered you can usually hear a faint buzz as it warms).

A check on the timer is to turn on the heater element with the pull cord and check the voltage on pin 7 of IC1. It should change between ground and +9 V every few seconds as pin 7 is Q4 of the timer divider chain. Higher order divider outputs can also be checked by referring to the circuit diagram. Each higher order output should change state at half the frequency of the one before. When the pull cord turns the heater off, all the Q outputs should be at 0 volts.

After that, mount your new power saving heater on the wall and make sure that it does shut off after the set time; then watch your power savings grow! ●



Board artwork. Full size reproduction of the pc board artwork.



Cutting the switch. The Jeanrenaud switch has to be cut as indicated.

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Metal can top screw terminals, High Current includes clamp and screws. Made by Siemens and Marcon.

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10,000/25V..$ 6.60	15,000/40V..$12.25	880/350V.....$15.85
22,000/25V..$11.25	22,000/40V..$14.25	3,100/450V..$75.85
33,000/25V..$13.50	47,000/40V..$25.50	
47,000/25V..$17.50	22,000/50V..$13.50	

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Superlow power 3½ digit LCD DVM TSC7126	$19.50
Dual power MOSFET driver TSC450	$ 4.95
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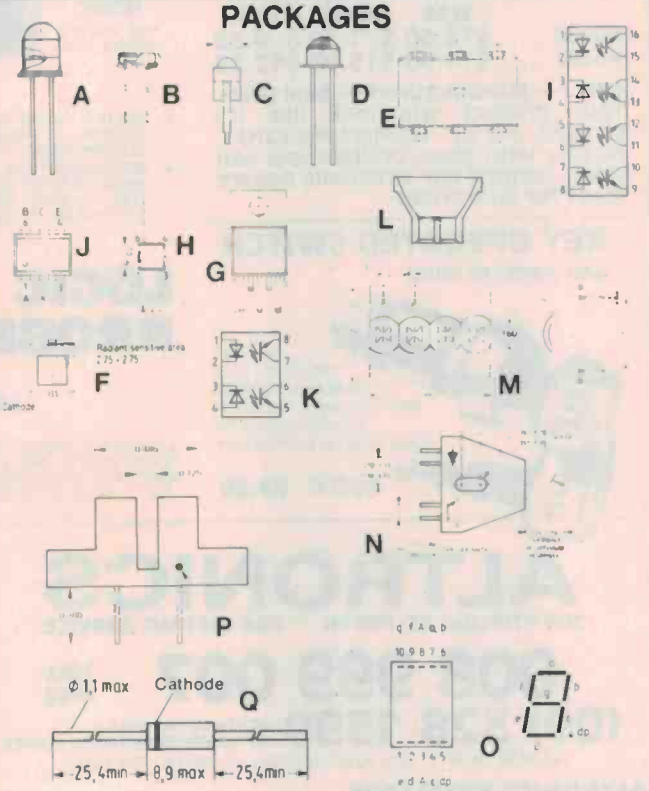
PACKAGES



SIEMENS COMPONENTS DATA BOOK 1983

This fantastic book has 600 pages of data on the SIEMENS range of semi-conductors, capacitors, ferrites, relays, thermistors, magneto detectors and all manner of exotic devices.

Really GREAT value at $10.00 (includes postage)

SUBMIN R. F. CHOKES

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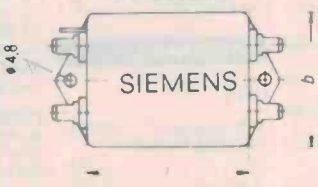
33	Microhenry	3.3	Millihenry
47	Microhenry	4.7	Millihenry

PROTECT YOUR DATA WITH THE PROMARK PULSE PRUNER



The PROMARK PULSE PRUNER is a high energy metal oxide varistor and a multi-element balanced LC line filter which work together to clip spikes and hold back RF interference. These are a must for computer power Inputs — Also great for Hi-Fi's to keep out taxi's, CB's, etc., from your Wagner & Strauss.

Rated 240V —4 AMP
$28.50

SIEMEN'S T092 TRANSISTORS

SPECIAL!

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BC548	BC557
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Why waste your valuable cash? Altronics staff are waiting for your call now (up to 6pm eastern standard time).

NEW HITACHI F SERIES
SQUARE SCREEN DUAL BEAM CRO

V-212 DC to 20 MHz, 1 mV/div, DUAL-TRACE

We are proud to include Hitachi's latest oscilloscope in our range of test equipment.

It features: • Thin, light and compact design (310W x 130H x 370D mm, 6 kg) • Large 6 inch rectangular, internal graticule CRT • Vertical mode triggering selection to provide stable triggering of each channel • High accuracy ± 3% • High sensitivity 1mV/div • Stable, low drift design • TV sync separation circuit builtin • Convenient X-Y mode for phase difference measurements • Tilting bail supplied.

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BUY THE BULK 150g PACK — IT'S 378% MORE ECONOMICAL!

Heat conducting paste facilitates heat transfer from semi to Heatsink. One tube good for up to 30 T-03 package semiconductors.

Fantastic Value

H1600...7.5gm Pack..... **$1.80**

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DIODES SLASHED

	Were	This Month	100+
IN4002.....	8c	6c	5c
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SENSATIONAL LOW PRICE

Handy little solid-state audio "Buzzer" or signalling device. Just the shot for communicator panels, or for timer alarms or in the car. Polarity conscious.

S5062... **$1.95** 10 Up... **$1.75**

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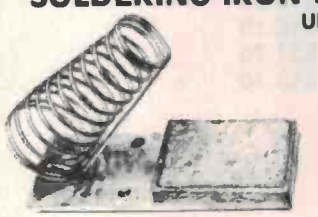
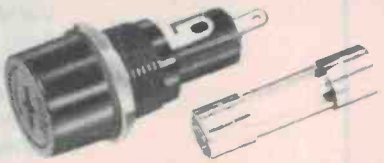


$5.95

VERO TYPE STRIP BOARD
Alpha numeric grid. Pre drilled .9mm, 2.5mm spacing, 95mm wide. 3 handy lengths.

H 0712..... 95 x 152 ONLY **$2.50**

MASSIVE 30 AMP RATED PANEL MOUNT FUSE HOLDER



Remember the hassle in providing high current circuit protection? The options are few — expensive industrial fuse assemblies costing $10 or more or circuit breakers (costing an arm and a leg). Well here is the answer — our nifty new panel mount fuse holder. **It's like a big, big brother to the 3AG Style.** The 10mm x 38mm fuses are an industry standard of course — naturally though, **ours cost somewhat less than industry standard prices.**

Panel hole size 15/16 inch is perfect although 1 inch or 25mm is OK.

Simple One Hole mounting — no more expensive panel cutouts, brackets.

	each	10+
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Z0155.....	22c	19c	15c

MINI SPEAKER 57mm
200 MW 8 OHM

Large Ferrite Magnet. Ideal replacement speaker. Great for hobby projects.

C 0610... $1.95
10 Up... $1.50

MINI SPEAKER 82.5mm (3¼ in.)
3 watt 8 OHM

Mounting Holes at 71mm centres.

C 0612... $4.75
10 Up... $4.25

INCREDIBLE VALUE BULK PACKS
ALL COMPUTER SELECTED

SUPER PRICE

$5 each

R3501.....25W Resistor Pack Av. contents 300.	$12 Value
R3510.....Greencap Pack 100V Av. contents 50.	$12 Value
R3515.....CERAMIC PACK 50V Av. contents 100.	$14 Value
R3520. ELECTROLYTIC PK. PCB TYPE Av. contents 40.	$14 Value

165 mm (6½ in.)
Dual Z 4/8 OHM
3 Watt RMS
Mounting holes at 112mm.

C 0620... $7.95
10 Up... $7.25

100 mm (4 in.)
Dual Z 4/8 OHM
3 Watt RMS
Mounting hole centres at 82mm.

C 0616... $5.25
10 Up... $4.75

FOR DESPATCH, P & P CHARGES AND ADDRESS DETAILS PLEASE REFER TO OUR AD. ON PAGE 140.

ALL ELECTRONIC COMPONENTS

118-122 LONSDALE STREET, MELBOURNE, VIC. 3000
(03) 662-3506

Kitset Specialists, here's just a few!

Worried about the ever-increasing burglary and theft figures? Well, by popular demand we again offer you a range of alarm and sensor Kitsets at special prices—

10% (or Greater) Saving

Can you afford to have your property "borrowed"?

Kits Available Include:—

● **ETI 582 House Alarm**(July '77)
$85.70, $7.88 cert. p & p
Features: ★ Facilities for a wide variety of sensors
★ Test circuits
★ Resets automatically
★ 30 sec. silent entry
★ 7 perimeter circuits
★ 4 internal circuits

● **ETI 702 Radar Intruder Alarm** (May 75)
$118.80, $8.88 cert. p & p
Features: ★ 10 metre range
★ Gunn diode assembly
★ An amplified output
★ 5-pole low pass filter
★ Detector and relay driver

● **ETI 528 Home Burglar Alarm** (Jan 75)	**$30.10**	*$5.00 p&p*
● **EA 10GHz Radar Alarm** (July 77)	**$98.25**	
● **ETI 250 Simple House Alarm** (Aug 80)	**$19.25**	

And here's some to protect your car:—

● **ETI 313 Car Alarm** (Nov 74)	**$18.00**	*$5.00 p&p*
● **EA 1976 Car Alarm** (Nov 76)	**$23.80**	
● **ETI 330 Car Alarm** (July 81)	**$35.50**	
● **ETI 340 Car Alarm/Monitor System** (April 84)	**P.O.A.**	

Other alarms include:—

● **ETI 583 Gas Alarm** (Aug 77)	**$50.20**	*$5.00 p&p*
● **ETI 247 Soil Moisture Indicator** (Nov 80)	**$19.40**	
● **ETI 332 Over Rev Car Alarm** (includes case)(Mar 80)	**$24.19**	

OK—You've found the alarm you need—How about a sensor

● **ETI 585 T&R Ultrasonic Switch** (Sept 77)	**$34.70**
● **ETI 570 Infra-Red 'Trip' Relay** (inc. plugpack) (Jan 82)	**$40.95**
● **ETI 711 Remote Control Unit** (July-Oct 76)	**P.O.A. As per Modules Required**

● **ETI 711 Remote Control Unit** (July-Oct 76)

Transmitter Switch	**$62.99**
Receiver	**$30.00**
Decoder	**$18.99**
Single Control	**$18.10**
Double Control	**$21.70**
Power Supply	**$13.40**

Features: ★ Many applications
★ Operates up to eight devices
★ 500m Range—Aerial up
★ 50m Range—Aerial down
★ 9V Power Supply

● **Genuine Aluminium Alarm Tape—$7.98 per 33m roll**
● **Alarm Terminal Strips—$0.50 each.**

• Importers • General Sales • Radio Equipment • Microwave Equipment • Radar Equipment • Pulse Techniques • Industrial Electronics • Instrumentation •

ERRORS AND OMISSIONS EXCEPTED

These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.

An eye for a Cylon

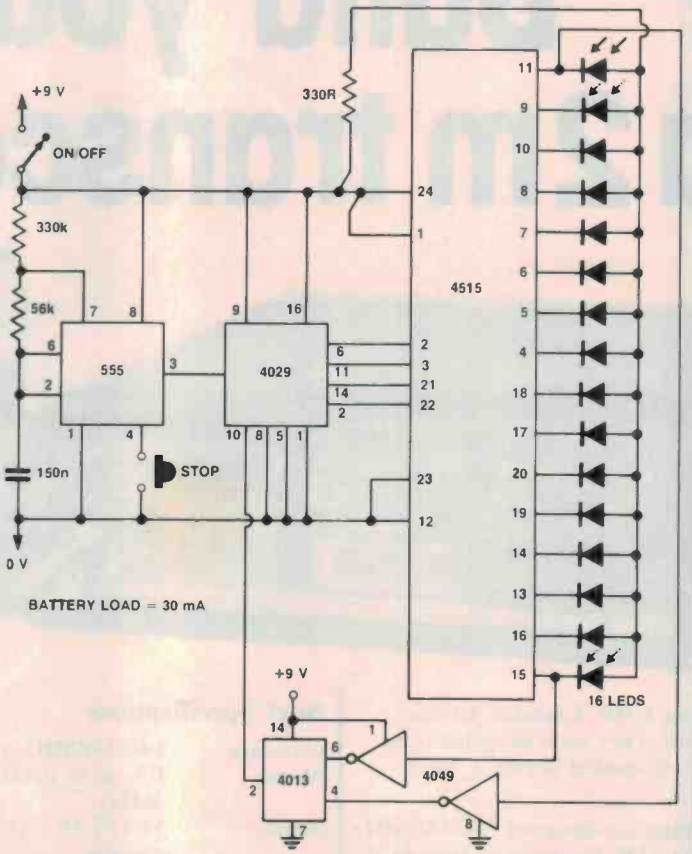
Fred Lever, Toongabbie NSW

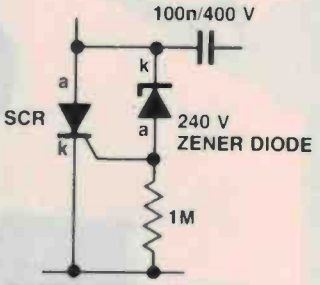
Recently I went to a fancy dress party and inspired by the TV series, I went as a dastardly Cylon. The voice was provided by your Sound Bender (ETI February 1982). However, I still had to make the single red eye as a blind Cylon at a party is not much chop.

A 555 timer drives a 4029 hex up-down counter. It's output is fed to a 1-of-16 decoder, which in turn lights one of 16 LEDs. The 4013 flipflop is used to change the direction of the counter whenever the first or sixteenth LED lights. The pushbutton is used to stop the eye, as this is what happens when a Cylon 'thinks' hard.

The circuit, mounted in the helmet, looks quite effective and the speed of the eye is about the same as a 'real' Cylon.

Note that the circuit could be simplified by using a 4514 and leaving out the 4029, but I couldn't get my hands on one.





PORTION OF SCHEMATIC DIAGRAM OF STROBE SHOWING MODIFICATION

Strobe Modification

Mark Hedley of Chatswood NSW constructed the disco light strobe project ETI-574, and found a few problems with it.

He found that the flash rate was slightly irregular and dependant on the ambient light level.

The problem was solved by replacing the neon indicator tube with seven 33 V zener diodes, to give a total zener voltage of 231 V.

Joystick

The poor quality of the joystick supplied with the Commodore 64 caused some problems to **Greg Symons of North Carlton Victoria**. He replaced it with a commercial quality one which he bought from an amusement distributor for $28.

The problem was that the new joystick needed to be rewired and mounted in a proper box so that it could be used with the Commodore. He found a box of suitable dimensions, and mounted the joystick and two fire buttons in it. He then connected some rainbow cable between the four micro switches and the joystick, the fire buttons and the computer's input port. The connections are:

Pin 1 Joy A0 Up
Pin 2 Joy A1 Down
Pin 3 Joy A2 Left
Pin 4 Joy A3 Right
Pin 6 Fire button
Pin 8 Common

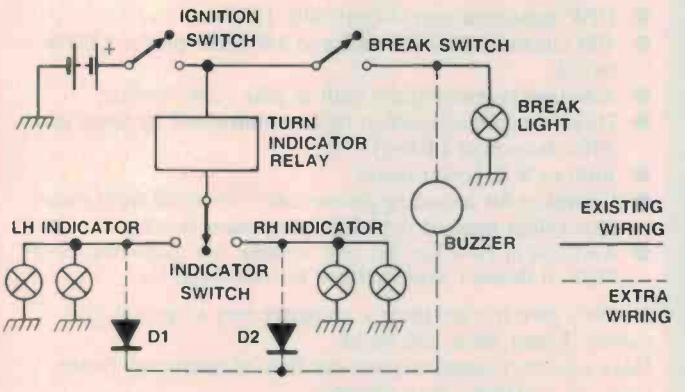
Buzzer inhibitor

Kevin Lowton of Seven Hills NSW fitted this circuit to his motorbike where it performed faultlessly for twelve months.

Some motorcycles have a buzzer that sounds in conjunction with the turning indicators to remind the rider to cancel them. This system works well, but it suffers from the problem of irritating both the rider and surrounding motorists when the rider is caught in traffic. What is needed is a foolproof way of inhibiting the buzzer while the bike is stationary. This simple circuit contains only three components yet it not only inhibits the buzzer but acts as a brake light fail indicator as well.

When either blinker is selected, currect is fed through the buzzer via D1 or D2 and flows to earth via the brake light. When the brakes are applied the buzzer is shorted out. If the brake light goes open circuit or if the brake light switch needs adjustment then the buzzer will not work.

The whole circuit is small enough to fit inside the headlight assembly of most bikes, with the added advantage that all the wiring is usually accessible there.



Ready for a new challenge? Build yourself a 2m transceiver

So many amateurs who built our UHF 'Explorer' kit have written in and asked us for more. They were delighted to be able to build something again – instead of buying a 'black box'! But they wanted more . . .

Here it is: A brand new all-Australian designed 144-148 MHz build-it-yourself transceiver: the VHF Commander from Dick Smith Electronics.

Featuring . . .

- 10W minimum output (typically 15W)
- 400 channels between 144 and 148MHz plus a +5kHz switch
- Standard repeater splits built in plus "anti" switch
- Direct frequency readout from thumbwheel switches (no difficult-to-read LEDs!)
- Built-in S & power meter
- Complete kit including deluxe case, screened front panel plus solder masked pcb with component overlay.
- And just in case you get into trouble: our exclusive 'Sorry Dick, it doesn't work' service for one fixed fee.

Go on – give it a go: there's no better way to get on to 2 metres. Learn while you build!
Have you ever heard anyone say they're operating 'home brew' on 2? Here's your chance!

Brief Specifications

Coverage:	144-148MHz in 10/5kHz steps
Mode:	F3, up to 10kHz deviation (normal operation 5kHz)
Supply:	12-15V DC, 110mA-300mA receive, 2.5A transmit
Power output:	10W minimum, typical 15W or more
Protection:	3A in-line fuse, reverse polarity protection. Can withstand 5:1 VSWR (inc short/open circ) for 2 minutes; audio can withstand open circuit indefinitely and momentary short circuit.
Transmitter	
Distortion:	Less than 10% at 3kHz deviation
Spurious:	Better than 60dB below carrier.
Harmonics:	−60dB
Receiver	
Sensitivity:	Max 0.5uV for 12dB SINAD (typically 0.4uV)
Selectivity:	60dB at ±25kHz
Audio:	1 watt output into 8 ohms response 6dB/octave, de-emphasis from 1kHz

BUILD IT YOURSELF AND SAVE!!!
Includes comprehensive instruction manual plus mounting hardware.

All this for only . . .
$199.00

As described in Electronics Australia, June 1984 issue

DICK SMITH ELECTRONICS

See page 160 for address details

A764/KT

STOP CRIMS!

Install these quality alarm systems at do it yourself prices!

Amazing Security Centre

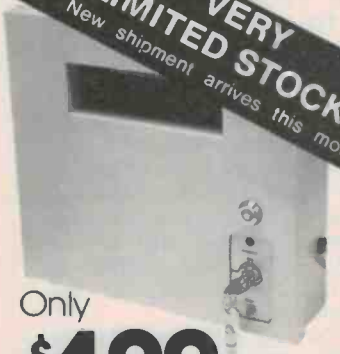
VERY LIMITED STOCKS
New shipment arrives this month

This is it! The most professional alarm system we've ever seen — and it's suitable for homes, offices, factories. . . you name it! With six individual sectors all full controllable for instant or delayed alarm, each able to isolate and each triggerable by a huge range of sensors: the type of alarm used by banks, etc where security is paramount.

- Resistive loop sensing suits both n/o & n/c alarm sensors. Bridging out cutting sensors will trigger the alarm.
- Suit most type of detection devices.

Cat L-5100

12V Rechargeable Battery to suit. Cat S-3442 $24.95



Only **$199**

Catch them electronically

Ultrasonic Sensor

Just **$65**

12V operated, works on doppler principle. Has provision for remote switching. Trigger any alarm unit. Cat L-5109

Microwave Sensor

Only **$95**

Works through plaster, fibro, etc. Very handy for complete concealment! 12V operated, both n/o & n/c contacts. Range up to 15 metres. Cat L-5000

Infra-Red Detector

It's a steal at **$99**

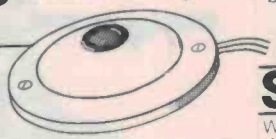
Ideal for doorways, halls etc. Operates when beam is cut (ie when someone walks through it!) Range from 0.8 to 15 metres. Cat L-5050

One step. . . and they're gone!

Only **$19.50**

Hide a pressure mat under the carpet, a rug - even the lightweight Bill Sykes can't get past this one! Put one in front of your safe! Normally open contacts. Cat L-5270

Protect against fire, too!



Only **$7.95**

The above Security Centre (and most alarms!) have provision for a fire sensor. Take advantage of it - and protect your home & property! Use any number of sensors in likely 'hot spots'. Cat L-5254

Blast 'em!

Know what a crook hates most? Noise! Scare the pants off them with this high efficiency horn speaker. Connects to alarm speaker output. Really loud. Cat C-2705

Just **$10.25**

Give em the gong!

A real loud fire bell is great for scaring them off, too. This one is 12V operated, draws just 300mA and can be heard blocks away! Cat L-5280

Only **$34.95**

Scare em off!

Warning stickers are a great deterrent in themselves. The thief doesn't know which type of alarm you have - so tries someone else's place instead! Self-adhesive, brightly coloured. Cat L-5310

$1

STOP PRESS

Just arrived: Swiss made Passive Infra-Red detector- top quality, no false alarms! Cat L-5010 $119.00

EXCLUSIVE

Your Home is on the 'hit list' - your valuable property maybe the gleam in a crooks eye tomorrow! You need help!!!

Here it is: our specially written guide to installing a fully professional alarm system - and it's free with any purchase of $1.00 or more for June only! That's right: every home now needs protection - and we'll show you how to install an alarm that will deter even the most persistant pest. . .

FREE!

Ask for your copy when you're in a Dick Smith Electronics store - or with your next mail order.

DICK SMITH ELECTRONICS

HFC

bankcard welcome here

See page 160 for full adress details

A765/JL

Random tone generator

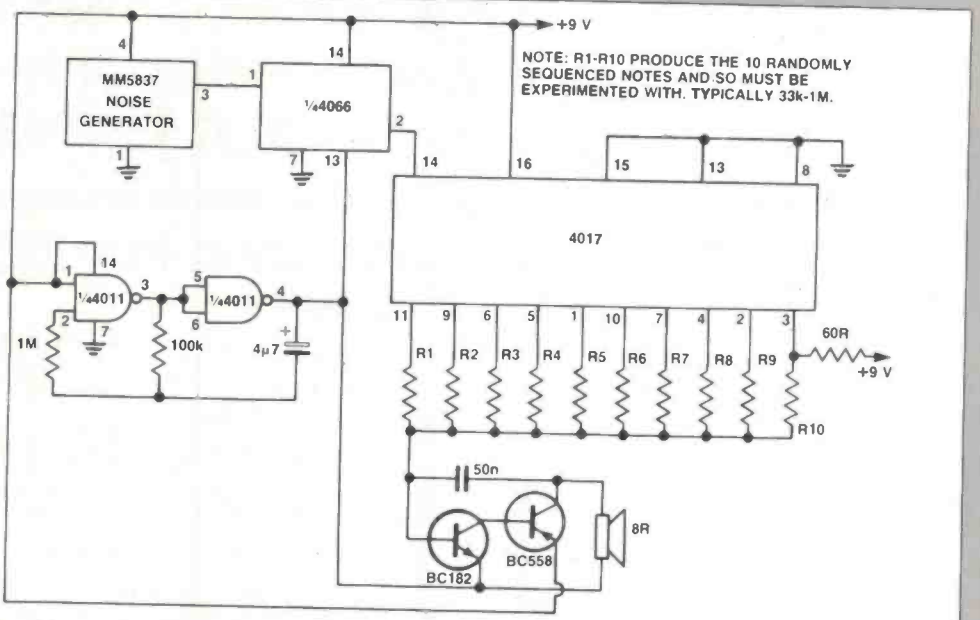
When **David Hughes** of **Howrah Tasmania** was working on a project to design a reasonably small robot he found that he needed a randomly sequenced 10-note generator to provide his 'pet' with a voice.

The MM5837 is a bit unnecessary (a fast clock would do) but I found that the random sequences would be better if this chip was used. The MM5837 supplies noise to the 4066 digital switch and the clock formed by the two 4011 NAND gates periodically lets a few noise spikes through via the switch control pin 13. The clock operates at about 1-2 Hz with the 4µ7 capacitor.

The noise spikes are fed to the clock input of a 4017 decade counter/decoder. When a logic '1' appears at pin 13 of the 4066 the 4017 is clocked a random number of times.

When the 4011 clock output is high the 'organ' formed by the transistors and resistor network is off so that notes cannot be produced while the 4017 is being clocked. This stops a terrible racket from being produced each time clocking occurs. When the 4011 clock goes low again, the tone generator is switched on and the tone selected by the 4017 is played.

As each pulse received by the counter moves the logic '1' output to a different pin i.e: pins 1, 2, 3, 4, 5, 6, 7, 9, 10 or 11 when clocking has finished, the logic '1 could be on any of these ten outputs because of the random noise spikes that produced the clocking.



'IDEA OF THE MONTH' CONTEST

COUPON

Cut and send to: **Scope/ETI 'Idea of the Month' Contest, ETI Magazine, P.O. Box 227, Waterloo NSW 2017.**

"I agree to the above terms and grant *Electronics Today International* all rights to publish my idea in ETI Magazine or other publications produced by it. I declare that the attached idea is my own original material, that it has not previously been published and that its publication does not violate any other copyright."*

* Breach of copyright is now a criminal offence.

Title of Idea .....

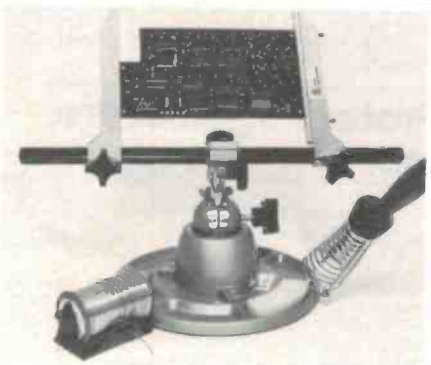
Signature .....

Name .....

Date .....

Address .....

..... **Postcode** .....



Scope Laboratories, which manufactures and distributes soldering irons and accessory tools, is sponsoring this contest with a prize given away every month for the best item submitted for publication in the 'Ideas for Experimenters' column — one of the most consistently popular features in ETI Magazine. Each month we will be giving away a pc board Work Centre consisting of the Model 315 adjustable pc board holder with capacity to accept 300 mm boards, Model 300 180° swivel and lock base which can be attached to the Model 312 tray base with wet sponge receptacle, Model 371 solder spool holder and Model STS 3 soldering iron safety stand. Please note prize does not include solder or scope TC60 temperature controlled iron shown above. The prize is worth $123!

CALL YOURSELF AN EXPERIMENTER, DO YOU?

All the recent entries for the 'Idea of the Month' contest haven't been good enough to win the new prize. That's really unfortunate for you, especially as the prize is now bigger and better and worth more than it used to be. $123 now!

So how about improving your efforts and sending some decent entries in?

Scope pc board
Work Centre

PRIZE WORTH $123!

Selections will be made at the sole discretion of the editorial staff of ETI Magazine. Apart from the prize, each winner will be paid $10 for the item published. You must submit original ideas of circuits which have not previously been published. You may send as many entries as you wish.

RULES

This contest is open to all persons normally resident in Australia, with the exception of members of the staff of Scope Laboratories, The Federal Publishing Company Pty Limited, ESN, The Litho Centre and/or associated companies.

Closing date for each issue is the last day of the month. Entries received within seven days of that date will be accepted if postmarked prior to and including the date of the last day of the month.

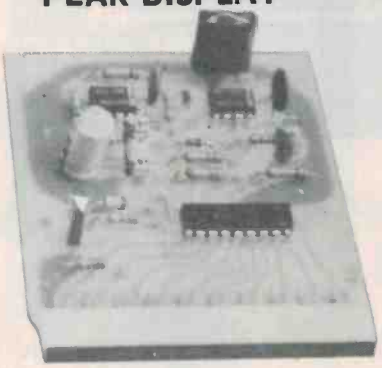
The winning entry will be judged by the Editor of ETI Magazine, whose decision will be final. No correspondence can be entered into regarding the decision.

The winner will be advised by telegram the same day the result is declared. The name of the winner, together with the winning idea, will be published in the next possible issue of ETI Magazine.

Contestants must enter their names and addresses where indicated on each entry form. Photostats or clearly written copies will be accepted but if sending copies you must cut out and include with each entry the month and page number from the bottom of the page of the contest. In other words, you can send in multiple entries but you will need extra copies of the magazine so that you send an original page number with each entry.

This contest is invalid in states where local laws prohibit entries. Entrants must sign the declaration on the coupon that they have read the above rules and agree to abide by their conditions.

LED BARGRAPH PEAK DISPLAY



This easy to build level meter uses our exclusively imported LED bargraph module which gives it a very professional finish indeed. Indicates from —21dB to + 6dB using a logarithmic scale. **Great Value!**

K 5412 ..... **$16.50**

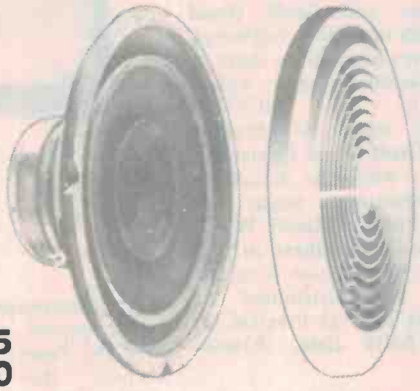
8 INCH WIDE RANGE DUAL CONE SPEAKER

200mm (8 in.). 10 Watts Max. power input. Public Address, Background Music. Ideal HI FI extension speaker. Includes transformer holes at 51mm. Over 30,000 sold in Australia! Mounting holes 140 x 140mm.

C2000 ..... **$9.50 ea**
10 Up **$8.70**

8 INCH CEILING SPEAKER GRILL

C0800 ..... **$2.75**
10 Up **$2.00**



MICROWAVE OVEN LEAK DETECTOR

ETI PROJECT

Completely passive project receives microwaves via an antenna which develops a voltage across a detector diode driving the meter.
Monitor your microwave oven with this easy to build kit. All components mount on single PCB, including the meter.
Genuine Hewlett Packard Hot Carrier Diode supplied.

K1724 ..... (still only) **$14.50**

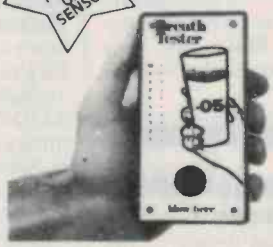
THE DAZZLING MUSICOLOR IV PROJECT

Combination Colour Organ and Light Chaser. Four channel colour organ. Internal micro-phone or connect to speakers for colour organ operation. (The lights connected to each channel pulse in beat to the music proportional to portion of frequency spectrum concerned.) Four chaser modes forward and reverse. Output lamp load capacity a massive 2400 watts — that's 100 party globes. Full instructions and every last nut and bolt included. Great for parties, shop signs, display windows etc.

K5800 ..... **$89.50**

ALCOHOL BREATH TESTER

GENUINE FIGARO GAS SENSOR



K1583 ONLY **$29.95** (SEE EA MAY 1983)

This Great new kit from EA will be a smash hit with all the smashed people at your next party. Fun to build. Fun to calibrate and Fun to use. More seriously, this unit could save lives.

WAS $199 SAVE $74

FAMOUS VOYAGER CAR COMPUTER

AS REVIEWED
EA OCT '82 P26-28
ETI NOV '82 P26

COMPLETELY BUILT AND TESTED

MADE IN ENGLAND! — QUALITY!

ONLY $125

Contains equivalent of thousands of transistors — uses massive custom LSI chip to achieve low price.
Never before has such a comprehensive car performance computer been offered at such a low price! Once again miracle microprocessor technology has enabled us to pass enormous savings on to you!
But don't let the low cost fool you. The "Voyager" car computer **is the most comprehensive product that we have seen.** No other car computer matches this one **at even twice the price!** You could buy a $20,000 Holden and not get a better car computer!
Just check the features. We are sure that you will calculate that the "Voyager" represents outstanding value!
FEATURES: ★ Instant fuel consumption in litres/100km and MPG! (most others have only one of the above) Just switch from one to the other as you drive along. ★ Instant speed, time and other fuel data. ★ Visual and audible excess speed alarm.
INSTALLATION: The "Voyager" comes complete with an unbelievable array of mounting configurations, on dash, under dash or stalk mount. All installation hardware is supplied (even a roll of insulation tape!) as well, of course, as the speed and fuel sensors. A lavishly illustrated installation manual is provided as well as a comprehensive operators manual.

DIL SWITCHES

GOLD PLATE SELF-WIPING CONTACTS.

LAST MONTH AT THIS PRICE

	EA	10Up
S 3050 4 Way	$1.50	$1.35
S 3060 8 Way	$2.00	$1.75

SUPER TYPE GLUE

High Bonding Strength sticks in seconds

T3010 $1.95
SAVE A DOLLAR

2N3055's SLASHED

Quality "SGS"

Z1174
$1 ea

IC SOCKETS DIL

LOW PROFILE

SAVE A FORTUNE

	ea.	10+	25+
P 0550 8 Pin	.18	.15	.10
P 0560 14 Pin	.20	.18	.15
P 0565 16 Pin	.20	.18	.15
P 0567 18 Pin	.30	.25	.20
P 0568 20 Pin	.50	.45	.42
P 0569 22 Pin	.60	.50	.47
P 0570 24 Pin	.45	.40	.35
P 0575 40 Pin	.65	.55	.45

ETI-275 strip heater time-out

Component availability for this project should present few difficulties, except perhaps for the switch, SW1. The one used is made by Jeanrenaud, type TJ, distributed here by STC-Cannon. The triac, Q6, is made by RCA, distributed here by AWA Microelectronics.

We understand that kits for this project (probably without the strip heater) will be available from **Rod Irving Electronics** in Melbourne and possibly **All Electronic Components.**

For those making their own pc boards, a same-size positive or negative film transparency is available for just $1.40 post paid from:

'ETI-275 Artwork'
ETI Magazine
P.O. Box 227
Waterloo NSW 2017.

When ordering, make sure you specify positive or negative, according to what your photoresist requires. Make out your cheque or money order to 'ETI Artwork Sales'.

ETI-669 pangalactic EPROM eraser

The heart of this project is the ETI-265 Power Down Timer, which we published in July 1983. Kits for this are probably available from **Jaycar** and **Avtek** in Sydney, **Rod Irving Electronics** and **All Electronic Components**, both in Melbourne, and **Altronics** in Perth. Printed circuit boards are available from the suppliers listed at the end of the column. Components are generally available.

The Philips TUV 15 W UV tube, type G 15 T8, is available from **Circuit Components, 383 Forest Rd, Bexley, NSW 2207. (02)59-3720**, and possibly other outlets.

A positive or negative same-size transparency of the ETI-265 artwork is available for just $1.85 post paid from:

ETI-265 Artwork
ETI Magazine
P.O. Box 227
Waterloo NSW 2017.

Please specify whether you want a positive or negative, according to your requirements. Your cheque or money order should be made out to 'ETI Artwork Sales'.

ETI-1523 electronic scales

For those hunting around for parts between now and the next issue when the construction details of the project will be published, the following might be helpful: The Bimbox 6007 case is stocked by **Jaycar**; the close-tolerance resistors are stocked by **Crusader Electronics** of St Peters in Sydney; the CA3240E op-amps are stocked by **Rod Irving Electronics** in Melbourne and **Geoff Wood Electronics** in Sydney (although other stores might have them as they're becoming more widely available); the 74C935N/ADD3501 might be obtained through **Geoff Wood Electronics** in Sydney while the metallised poly capacitors might be obtained through **Geoff Wood**, too, as well as **Semikron** in Sydney. The Neosid core is manufactured and distributed by **Neosid Pty Ltd, 23 Percival St, Lilyfield NSW 2040. (02)660-4566.**

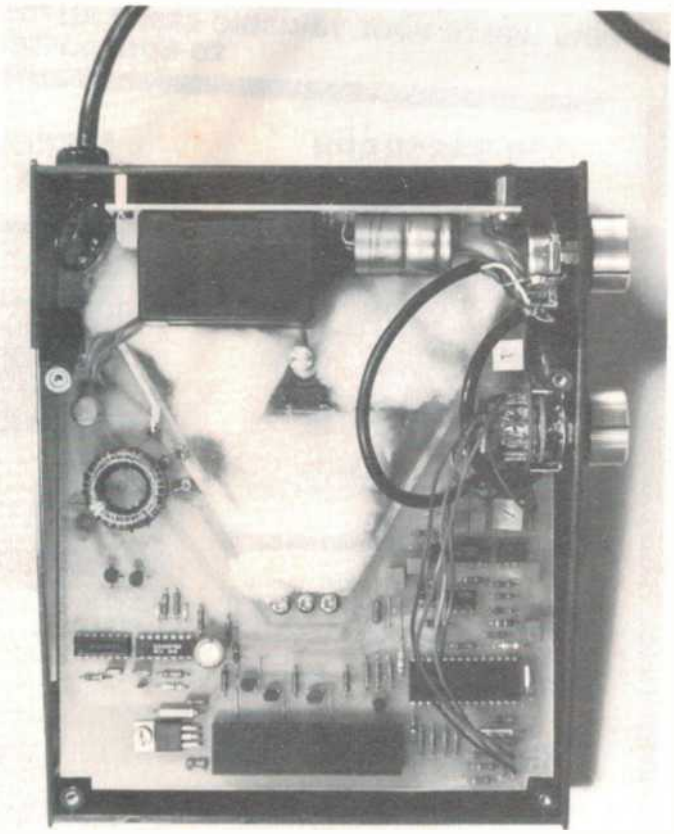
ETI-162a power supply mod.

All the parts for this modification to our popular power supply are readily obtainable at virtually any electronics outlet. The printed circuit board should be obtainable from the suppliers listed at the end of the column. A positive or negative transparency of the board artwork can be obtained for $1.00 from:

'ETI-162a Artwork'
ETI magazine
PO Box 227
Waterloo, NSW 2017

Your cheque or money order should be made payable to 'ETI Artwork Sales'. Please specify whether you want positive or negative film, according to the photoresist you use.

We expect suppliers of the ETI-162 Power Supply kit will include the 'goof-proofing' mod. in future.



Printed circuit boards

Almost every pc board (and most front panels) ever published by ETI may be obtained from:

All Electronic Components
118 Lonsdale St
Melbourne Vic 3000

and

RCS Radio
651 Forest Rd
Bexley NSW 2207

For pc boards produced in recent years, the following suppliers either keep stocks on hand or can supply to order:

Acetronics
112 Robertson Rd
Bass Hill NSW 2197
(02)645-1241

Billco Electronics
Shop 2, 31 Pultney St
Dandenong Vic 2175

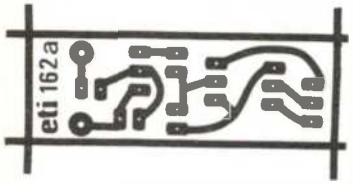
Jaetronics
58 Appian Drive
St Albans Vic 3021

Jaycar
117 York St
Sydney NSW 2000

Jemal Products
P.O. Box 168
Victoria Park WA 6100

Mini Tech
P.O. Box 9194
Auckland NZ

Rod Irving Electronics
425 High St
Northcote Vic 3070



GO FOR IT!

Dick Smith Electronics is Australia's Electronics Supermarket bar none! We won't be beaten on value or service, here's why . . .

Amazing Bargain!!

NEW

Hey! Calling all FT101ZD owners - and anyone else looking for an absolute bargain! FV101DM Digital VFO's - original price over $200 ...huge scoop purchase now only $99 each! Standard 5-5.5MHz output, 10 memories, optical coupling, digital keypad, etc. etc. - they should be adaptable to suit most HF transceivers. Hurry in for this one - don't say you weren't told!
Cat D-2948

$99

Manufacturer's surplus stock... you reap the benefit!

Giant Rubber Feet Pack
As used by giants everywhere. 25mm diam., 20mm high. With steel insert for strength. Use on b-l-g projects, appliances, jumbo jets, etc.
Pack of 4 for 60c
Cat H-1738

Fantastic Replacement Speaker
7 x 5 inch oval speaker, ideal for cars, etc. Impedance - 8 or 15 ohms. 5W power rating.
Slashed to just $4.50 each!! (Buy 5 or more and they're just $4.00 each!) Cat A-7137

Huge shipment of distressed stock arriving mid June...see next months mags for details and grab some while they last!

NEW

Get a load of these new computer connectors...while stocks last!

9 Pin Plug	P-2684	$2.20
9 Pin Socket	P-2685	$2.90
Backshell to suit	P-2686	$1.95
15 Pin Plug	P-2687	$2.95
15 Pin Socket	P-2688	$3.95
Backshell to suit	P-2689	$3.50

PLUS our existing range:

25 Pin Plug 'D' type	P-2690	$3.95
25 Pin Socket 'D' type	P-2691	$4.75
Backshell to suit	P-2692	$2.50
57-30360 Printer Plug	P-2680	$19.95
57-403360 Printer Socket	P-2681	$15.95

For a Dashing Dashboard!

12V Bezel

Bezel in dashboard tells thief there's an alarm - so he tries another car! Most alarms have flashing circuitry built in - lamp rated at 12V.
Cat S-3510 **95¢**

NEW

Build a deluxe 70cm Preamp Kit

Here's great value: an easy-to-build and even-easier-to-get-going receiver preamp for 70cm. Pull in those stations you never knew were there. It really can make the difference between a noise and a great copy!
As described in Electronics Today International May 1984 issue, achieves better than 2dB noise figure with around 18dB gain at 440MHz. Requires around 12V @ 5mA. Ideal for kit or commercial transceivers.
Cat K-6306

CB version - substitute our 470MHz helical resonator in above kit and it's ideal for UHF CB - with similar specs!
470Mhz Helical Resonator
Cat L-1860 $7.50

$19.95

$299 **'Go anywhere' 2M Hand Held FT203R**

Small enough to go in the briefcase, the back-pack, anywhere! Fully detachable battery pack for instant replacement, full 144-148MHz coverage in 10kHz steps plus 5kHz up switch. A must for the amateur on the go! Cat D-3500

Accessories for your FT203R:

Headset Mic/phone
Gives complete hands-free VOX operation. Lightweight and comfy.
Cat C-4200 **$29.00**
Speaker Mic
For mobile or base use, gives external PTT too. Ideal for noisy locations. Cat C-1112 **$39.00**
Mounting Bracket
Hangs over car window, holds the FT203R securely with access to all controls. Cat D-3501 **$19.50**

KEYBOARDS!!

UNBELIEVABLE SCOOP PURCHASE!

AIR FREIGHTED DIRECT FROM SILICON VALLEY

World famous 'Cherry' brand computer keyboards...fully assembled on quality 24 gauge steel frame and fibreglass PCB!

Absolutely brand new and guaranteed - made for a leading computer manufacturer who went broke (don't they all?) these amazing keyboards are ideal for building all sorts of computer projects.

- ★ 4 different types - we haven't the time to sort them!
- ★ Between 77 & 103 keys (depending on type), each individually switched!
- ★ Provision on some keyboards for moving many keys to different locations!
- ★ Matrixed output - matrix details available.
- ★ Some keyboards even have decoder chips and other components!
- ★ Buy two keyboards, use the switches from one to make up a massive 117 key keyboard in some types!

Cost original manufacturer over $100 each . . . worth over $200 normally . . . look at our ridiculous price!
Cat K-3621

ONLY **$49.95**

WORTH OVER $200!

Alarming Switches!

Reed Switch

The old faithful! Actuated by magnet, extremely reliable switch for all alarm systems. Tiny size is ideal for concealment, too.
L-5215
$1.85

Mercury 'Tilt' Switch

For boot/bonnet switches or tow-away sensors, etc. Mercury ball makes contact when tilted.
$1.50 Cat S-1935

Stick it in!

Vehicle Alarm Switch

Normally closed switch opens when door is closed. Ideal for alarms or interior lights, etc. Two in a pack.
Cat L-5256
$1.80

NEW

OWN A VIDEO?

Sick of the lousy sound most videos give you? Now you can build a kit to fix it – and what's more, get synthesised stereo as well!! Yes – a graphic equaliser specifically intended for video use: now you can really get the most from your video!

- Suits ALL VCR's
- Easy-to-build kit.

$49.95

Cat K-3422

TELEX

IT'S OFFICIAL . . .

DICK SMITH ELECTRONICS CONFIRMED NUMBER ONE . . .
250 STORES AND RE-SELLERS ACROSS AUSTRALIA AND NEW ZEALAND . . . 75,000 REGULAR MAIL ORDER CUSTOMERS . . . 1 MILLION DOLLARS SALES EACH WEEK GIVING CUSTOMERS THE ADVANTAGE OF MASSIVE BUYING POWER . . . THE WIDEST RANGE OF PRODUCTS FROM COMPONENTS TO COMPUTERS AND EVERYTHING IN BETWEEN . . .

NO OTHER COMPANY COMES CLOSE TO DICK SMITH ELECTRONICS . . . DON'T BE FOOLED BY MISLEADING CLAIMS AND STATEMENTS . . . DICK SMITH ELECTRONICS IS STILL NUMBER ONE IN AUSTRALASIA . . .

MESSAGE ENDS

TELEX

TELEX

NEW

Go Mobile . . .

Our kit antennas make it easy! And you'll save heaps by doing it yourself!!

VHF

(suits new 'Commander' 2m transceiver)

Deluxe Gutter Gripper with low-loss co-ax, plus VHF whip & cutting guide ready for two metre mobile.
Cat D-4024 **$24.95**

UHF

(suits 70cm 'Explorer' transceiver)

Gutter Gripper base plus low-loss co-ax, whip & cutting guide similar to above. A must for 70cm!
Cat D-4014 **$24.95**

No leak! Rechargeable!

12V Gel Cell

What happens if the crook cuts the car battery wire? The alarm goes off – if you have this back-up battery fitted! Cunning isn't it?
2.6Ah cap., 12V.

Amazing value!

$24.95

Cat S-3320

NEW

COMPUTER TIME

Want to be a two or three computer family? Try this one! Novelty LCD clock inside a tiny computer-shaped case. What a great gift idea too Don't miss out – limited stocks.
Cat Y-1039 **$4.95**

NEW

BUILD THE BEST CAR ALARM IN AUSTRALIA!

Every possible feature to protect your car – even provision for battery back-up!

* As described in Electronics Australia May 1984 – scores 9 out of 10 (the BEST commercial units score only 8!)

The Dick Smith Deluxe Car Alarm kit comes complete with a die-cast case – essential for use in a car. Don't buy el cheapo kits in plastic boxes!

And our kit is complete with ALL switches, sensors, dash bezel, front panel and quality horn speaker! Nothing extra to buy!

Cat K-3252

LOOK: DIE CAST CASE

$67.50

BLOW YOUR HORN!

Make a noise!

Deluxe horn speaker is ideal for alarms. Very efficient, makes a real din with siren in alarm itself. Cat C-2705

$10.25

AT LAST! TOP QUALITY PASSIVE I/R SENSOR

SWISS MADE

NEW

We've waited for a while to find these top quality units (not like a lot of inferior types you can find elsewhere!) Passive Infra Red sensor is by far the best type of sensor for your alarm – wind, curtains, etc. won't be set off.

Senses body heat from across a room – extremely sensitive and effective!

Add on to any alarm system for real protection!

Cat L-5010 **$119**

Switch it on!

Barrel Key Switch

Use with any alarm for internal or external key control. Comes complete with two keys.
Cat L-5290 **$7.25**

No. 1 in Australasia!

DICK SMITH ELECTRONICS

See page 160 for address details

Computers choose frequencies

A decision made at the recent World Administrative Radio Conference (WARC) at Geneva has altered the position as regards frequencies assigned to shortwave stations.

In the past, the international broadcasters submitted their frequencies and schedules to the *International Frequency Registration Board*, and in turn the IFRB allocated channels and tried to avoid mutual interference. This time consuming work is to be superseded with a new means of allocating shortwave channels in the future.

The major decision was that the Conference agreed that countries will file their requirements — hours and target areas — with the *International Telecommunication Union* (ITU) whose computer will determine optimum frequencies based upon propagation forecasts and other countries' requirements.

An international panel of experts representing the five main regions — Eastern and Western Europe, Africa, Asia and the Western Hemisphere — is being set up for programming the ITU computer with input from broadcasting administrations on desired signal strength, transmission times and power etc. Various options will be tested, resulting in recommended optimal frequencies for each broadcaster.

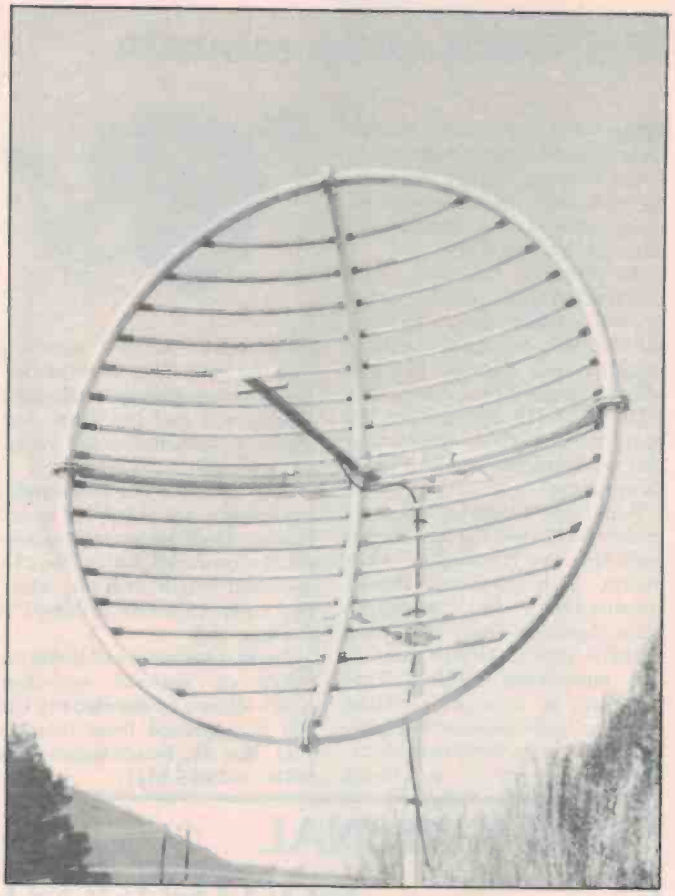
The aim is that these optimal frequencies ensure that every country can broadcast with a satisfactory signal 80% of the time on one or two frequencies and at a signal level strong enough for good reception.

The optimized plan of frequencies is due to be approved by the 1986 session. This session will also make a final decision on the introduction of single sideband broadcasting, and consider the present proposal concerning harmful interference where stations have the right to request a new frequency when the allocated channel is subject to interference.

The computerisation is to come out of the ITU budget enabling developing countries to benefit by it without having to pay for computers and associated software. It is hoped that the assignation of optimal frequencies will mean countries presently using perhaps half-a-dozen frequencies for a given target area will find they can get better results on just one or two frequencies.

The three umbrella organisations representing the world's radio clubs have all approved this new move in frequency allocation and see it as a way of reducing interference and giving the stations fewer frequencies but with better overall results. The *European DX Council*, the *North American Association of Radio Clubs*, and the *South Pacific Association of Radio Clubs* have all been involved in putting forward the views of the consumer — the shortwave listener — to the recent WARC meeting.

— **Arthur Cushen**



Dish grid kits

A range of parabolic antenna grid kits is available from antenna engineering Pty Ltd. They are claimed to be comparable in performance to normal welded grid parabolic antennas.

Coming in kit form, they have the singular advantage of compact size for shipping, greatly reducing transport costs and handling problems compared to build-up parabolas. Assembly requires only a few hand tools so installation at remote sites presents few difficulties.

Designed and manufactured in Australia by Antenna Engineering of Croydon, Victoria, standard versions of these antennas are available for the 450, 900 and 1500 MHz bands, for both horizontal and vertical polarisation, with unpressurised feeds.

Four sizes are available — 1.8 m, 2.4 m, 3 m and 3.7 m diameter. More information can be obtained from **Antenna Engineering Australia Pty Ltd, P.O. Box 191, Croydon Vic. 3136. (03)728-1777.**

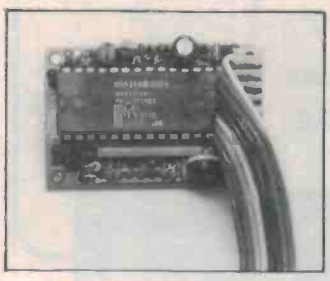
Squelch

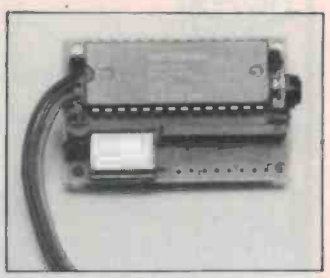
Two new continuous tone coded squelch controllers are now available from Signalling Technology.

Designated Sigtec C1003 encoder and Sigtec C1103 en/decoder, both modules are fully designed and manufactured in Australia.

The units were designed for VHF/UHF mobile and base radio equipment, and satisfy the Department of Communications requirement for a 'quiet base' facility.

For further information contact **Signalling Technology, Factory 8, 2 Aspley Place, Seaford Vic 3198. (03)786-0077.**





Well-built whip mounts

The weak link in any mobile communications installation is the antenna system. No matter how much money you spend on a whip and coax, the antenna base can let you down.

A properly designed, well constructed antenna base mount not only ensures good mechanical reliability but good electrical integrity too. Benelec Pty Ltd offers a range of base mounts for VHF and UHF applications, all of solid mechanical construction and with attention paid to cable termination.

Benelec's model 2-740 low-profile UHF type is a new model featuring a reinforced whip mount with all-metal thread construction. The mounting plate features four claws for positive vehicle chassis contact and mechanical rigidity. This plate can be removed enabling the base to be used with a general purpose groundplane eliminator. The cable is easily terminated, simply screwing into the base. The outer conductor is automatically terminated in this way and the inner conductor is soldered to the centre whip mount.

The model 2-720 is a similar low-profile type, for VHF installations. Both bases can be supplied terminated with cable of a specified length with any specified coax connector attached at the free end.

Further information about the range of antenna mounting bases offered by **Benelec Pty Ltd** can be obtained from them at **P.O. Box 21, Bondi Beach 2026 NSW. (02)665-8211.**

Handheld VHF

Bosch has released a synthesised handheld transceiver for the professional user, operating in the 146-174 MHz VHF high band, featuring a power output of 2.5 W and selective calling facilities.

Dubbed the model HFG164, it can be programmed for up to 32-channel operation. A full range of options is included, such as five-tone selective calling, vehicle mounting hardware and high capacity rechargeable NiCad batteries.

The transceiver is of modular construction and is contained in a dust and splash-proof metal housing. Full details on this and future Bosch transceiver releases can be obtained from **Robert Bosch (Aust.) Pty Ltd, Electronic Products Division, Cnr Centre & McNaughton Rds, Clayton Vic. 3168. (03)544-0655.**

New FM mobile

GFS Electronic Imports has announced the availability of a compact two metre FM mobile transceiver from Standard.

Known as the C-8900 its dimensions are 138 mm wide x 31 mm high x 178 mm deep. Small enough to slot into most of todays 'difficult to fit' vehicles.

The C-8900's receiver incorporates a GaAs FET RF amplifier stage. This, coupled with its mixer, IF and detector circuitry provides a receive sensitivity of 0.15 μV for 12 dB SINAD.

The full 4 MHz coverage is provided with 800 channels. Both plus and minus 600 kHz repeater offsets are also incorporated. The C-8900's built-in five memory channels may be automatically scanned or selected manually. Up-down frequency selection may be made from a switch built into the microphone.

The C-8900's transmitter section also uses the latest technology to achieve a power output of 10 watts into a 50 ohm load. Full protection is provided for the power amplifier stage.

A unique feature of the standard C-8900 is its ability to allow the user to slope upward, by 15 degrees, the digital readout. This allows easier viewing when under-dash mounting is used.

Price of the C-8900 is $442 plus $12 P&P. For more details contact the Australian distributors, **GFS Electronic Imports, 17 McKeon Road, Mitcham Vic. 2132. (03)873-3777.**

Maple Leaf brag

Arthur Cushen MBE

RADIO CANADA International commenced operation in 1945, with technical staff borrowed from the BBC and studios in Montreal. Before that the Canadian Broadcasting Corporation had relayed their domestic programme on shortwave with a 7500 W transmitter.

With the change in shortwave broadcasting arrangements came new, more powerful 50 kW transmitters. Special transmissions were instituted to many parts of the world, including the South Pacific, where the writer served as Technical Monitor.

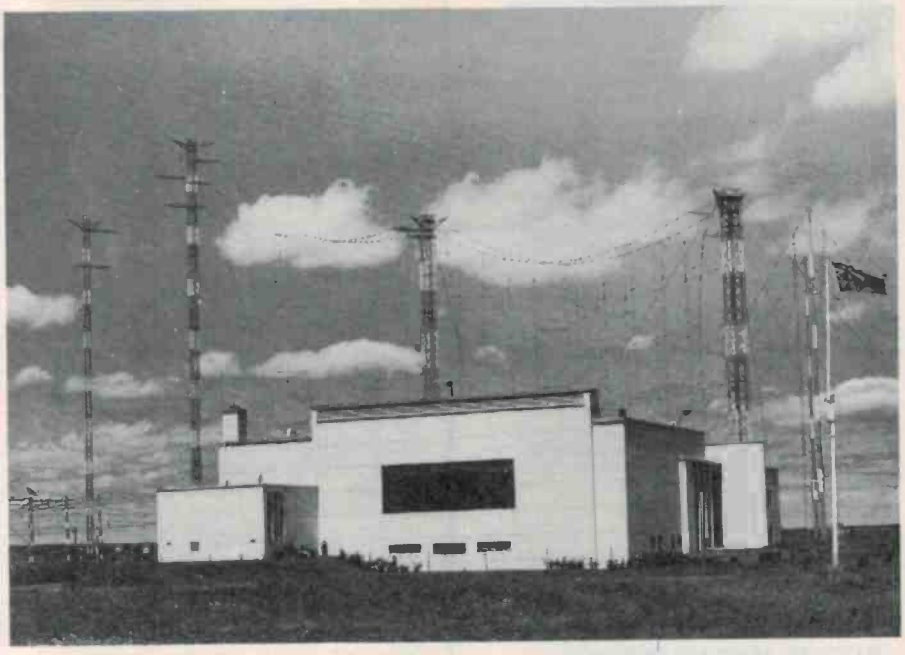
The transmitters in Sackville, New Brunswick, have now been increased to 250 kW. The complex consists of five modern 250 kW transmitters, supplemented by three lower powered transmitters. The 250 kW transmitters are controlled by a data processor into which is entered all the pertinent information of a given schedule well in advance of the actual time of transmission.

As many as 100 different functions (such as transmitters on and off, high power and low power, etc.) can be pre-scheduled for these five transmitters up to 24 hours before the time required. They are automatically tunable to any frequency within the range of 3.95 MHz to 26.5 MHz. The tuning operation takes 12 seconds or less to any point within this operating range. The five 250 kW transmitters are connected to the various antennas by a switching matrix in a building separate from the main transmitter building. All of the antennas at Sackville are curtain arrays, suspended from steel masts.

This type of antenna can be used to transmit in either of two directions, 180 degrees apart, by means of a simple switching operation. The current antennas are on beams to Africa, Europe (both reversible to North America), South America, the Caribbean, North America and Northern Canada.

The programmes produced in Montreal are sent to Sackville, a distance of 1000 km, over special microwave circuits.

Radio Canada operates a receiving station at Stittsville which monitors daily broadcasts beamed to North America by other international stations. Radio Canada's first monitoring station was at Britannia Heights. The writer spent some time at this monitoring station where signals are intercepted from many parts of the world for both frequency information and to form the basis of news bulletins.



Canada's overseas 'voice', the shortwave station Radio Canada International, recently upgraded its transmitting facilities and now boasts five 250 kW transmitters.

The new Stittsville monitoring station is much more sophisticated and, as well as evaluating signals received in the target area, it is also used as a back-up for direct off-air pick-up of BBC World Service programmes when the regular transatlantic satellite circuit linking the BBC in London and RCI in Montreal is not available.

Direct off-air pick up of Deutsche Welle German programmes destined for a North American audience is also a responsibility. These programmes of the BBC and Deutsche Welle are fed to Sackville, New Brunswick, for retransmission to North America as part of an exchange agreement. The two broadcast organisations relay RCI programmes destined for Eastern Europe from bases in Daventry, England and Sines, Portugal.

Radio Canada transmissions are received in Australia and New Zealand during the afternoon listening period. English programmes are broadcast at 0300-0329 hours UTC on 5960 Hz and 9755 Hz, and repeated 0400-0429 on the same frequencies. The morning transmissions in this area at 2130-2159 hours are on 11945, 15150, 15325, 17820, 17875 and 21695 kHz.

A special programme 'Shortwave Listeners Digest' is heard on Mondays at 0305 UTC in the service to North America and on Saturday at 2135 UTC in the broadcast to Africa, both services providing good reception. 'Shortwave Listeners Digest' is compered by Ian McFarland, and includes a weekly contribution of DX information from Glen Hauser. Other features include information on new receivers from Larry Lagne and an equipment review from Harold Sellars.

This article is contributed by Arthur Cushen, 212 Earn St, Invercargill NZ, who would be pleased to supply additional information on medium and shortwave listening. All times quoted are UTC (GMT), eight hours behind Sydney time, and all frequencies are in kilohertz.

CHEAP VIDEO COOKBOOK
G0123P **$12.90**
Complete discussion of a new, low-cost way to get words, pictures and opcode out of your computer and onto any ordinary television screen, using a seven-IC easy-to-build circuit which you can build for $20.

AN INTRODUCTION TO VIDEO
G0124B **$6.95**
This book is written in layman's language and is for anyone who is thinking about buying or renting or who has just bought or rented a video recorder and wants to get the best out of the machine.

INTRODUCTION TO ELECTRO-ACOUSTIC MUSIC
G0127P **$15.95**
This book assumes no previous technical knowledge. It discusses the relationship between the technology and the composition of electro-acoustic music.

MODERN RECORDING TECHNIQUES
G0128P **$21.95**
Explains the equipment controls and techniques found in a modern recording studio and how to use them creatively and correctly to produce a desired result. Numerous photographs, diagrams and charts.

TUBE SUBSTITUTION HANDBOOK
G0130P **$8.75**
Complete, accurate, up-to-date guide to direct substitutes for receiving and picture tubes. Contains more than 6000 receiving tube substitutes, 4000 monochrome and colour picture tube substitutes, and 600 communications substitutes. Also includes pinouts for quick operational checks.

ELECTRONIC SYNTHESISER PROJECTS
G0133B **$5.95**
For the electronic music enthusiast, an invaluable reference. This book is full of circuits and information on how to build analogue delay lines, sequencers, VCOs, envelope shapers, etc, etc. The author takes a clear and logical approach to the subject that should enable the average enthusiast to understand and build up what appears to be a quite complex instrument.

ELECTRONIC MUSIC PROJECTS
G0135B **$5.95**
Provides constructors with practical circuits for the less complex music equipment including fuzz box, waa-waa pedal, sustain unit, reverb and phaser, tremolo generator, etc. Text covers guitar effects, general effects, sound generators, accessories.

ELECTRONIC MUSIC AND CREATIVE TAPE-RECORDING
G0136B **$6.95**
Shows how electronic music can be made at home with the simplest and most inexpensive of equipment. Describes how the sounds are generated and how these may be recorded to build up the final composition.

PRACTICAL CONSTRUCTION OF PREAMPS, TONE CONTROLS, FILTERS, ATTENUATORS
G0137B **$5.25**
This book shows the enthusiast how to construct a variety of magnetic tape recording, microphone and disc preamplifiers, and also a number of tone control circuits, rumble and scratch filters, attenuators and pads.

computers for beginners

COBOL FOR BEGINNERS
H0140P **$33.95**
It is a solid text for introductory programming courses in Cobol, using a format that is easy to understand, yet comprehensive enough to make supplementary readings unnecessary.

THE PET PERSONAL COMPUTER FOR BEGINNERS
H0141P **$20.95**
This handy guide is written for use with all varieties of PET computer, from the original 2001 to the 8032 Super PET. It is suited to novices with no practical experience and provides advice and practical examples.

THIS MONTH'S SPECIAL

THE 6809 COMPANION
Normally $6.95; this month only.
$5.15
A discussion of the features of the 6809 and a reference guide. Don't be deceived — it's more than just a beginner's guide to microprocessors. To order quote book number JX154B
Limited supplies

BIG THINGS FROM LITTLE COMPUTERS
H0142P **$19.25**
A layperson's guide to personal computing with all the basic information and lots of examples of how personal computers can be used.

BEGINNER'S GUIDE TO MICROPROCESSORS AND COMPUTING
H0143B **$6.95**
Introduction to basic theory and concepts of binary arithmetic, microprocessor operation and machine language programming. Only prior knowledge assumed is very basic arithmetic and an understanding of indices.

A MICROPROCESSOR PRIMER
H0144B **$5.95**
Learning about microprocessors is easy with this book, written in a style that is easy to follow. The shortcomings of this basic machine are discussed and the reader is shown how these are overcome by changes to the instruction set. Relative addressing, index registers follow as logical progressions.

AN INTRODUCTION TO BASIC PROGRAMMING TECHNIQUES
H0145B **$6.75**
Ideal for beginners seeking to understand and program in BASIC. Includes program library for biorhythms, graphing Y against X, standard deviations, regressions, generating musical note sequences, and a card game.

BEGINNING FORTRAN
H0147A **$25.50**
Starts with simple elementary examples and proceeds to intermediate level programs. Also includes references, tutorials, flow charts, deck set-ups and matrix algebra.

UNDERSTANDING COMPUTERS
H0148A **$20.95**
For people who use small computers, this book starts with the most elementary gates and works up to the complete computer. Gives an understanding of the languages and how they operate in the computer.

PEANUT BUTTER AND JELLY GUIDE TO COMPUTERS
H0150A **$16.75**
A simple, easy-to-digest source of information on personal computing for the potential buyer who is less than an expert in the field.

COMPUTERS FOR EVERYBODY
H0270A **$8.95**
In this easy-to-understand book it is explained how a computer can be used at home, in the office or at school. Includes a consumer's guide to computer equipment that will help the reader decide what to buy and who to buy it from. Second edition.

YOUR FIRST COMPUTER
H0271A **$15.25**
An easy-to-understand beginner's book to small computers. Understanding them, buying them and using them for personal and business applications.

MODERN COMPUTER CONCEPTS
H0313P **$29.95**
The second volume in this series (following ETI Book Sales No. H0312P) covers subjects such as semiconductor memory devices, central processor units, magnetic memories, datacommunications, computer networks and videotex.

computer hardware and techniques

INTERFACE PROJECTS FOR THE APPLE II
J0158P **$17.95**
A series of interface projects that are easily built and enable the user to realise the computer's potential through project construction. Projects are primarily hardware-orientated, with some software supporting the hardware.

IAPX 88 BOOK
J0162P **$20.25**
This book from Intel itself describes the unique Intel 8088 microprocessor in total detail. Invaluable for all involved with the 8088.

A STEP-BY-STEP INTRODUCTION TO 8080 MICROPROCESSOR SYSTEMS
J0165A **$16.95**
Doesn't require any electronics or computer background. This book describes the 8080 architecture and instruction set through simple examples. Some basic software is introduced.

DIGITAL CIRCUITS WITH MICROPROCESSOR APPLICATIONS
J0166A **$46.50**
An introductory text, this book provides readers with the basic ideas and tools needed to analyse and design digital circuits and computer systems. Discusses microprocessor computer organisation, machine-language number systems and gate circuits.

Z80 MICROCOMPUTER HANDBOOK
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This handbook covers hardware, software and microcomputers built around the Z80.

APPLE INTERFACING
J0273P **$15.95**
Using this book, you will be able to perform useful experiments which will provide a much clearer understanding of the fundamentals of computer interfacing and computer electronics.

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Intended for those who want to progress beyond BASIC programming to topics such as machine-code and assembly language programming or who need hardware details of the Z80-based computer.

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The projects include a pulse detector, picture digitiser, five-key pad, model controller, bleeper, lamp flasher, light pen, etc, etc.

TV TYPEWRITER COOKBOOK
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A complete guide to low-cost television display of alphanumeric and graphics data for microprocessor systems, computer hobbyists, television titling, word-processing and video games.

Z80 USER'S MANUAL
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An all-in-one guide to Z80 pin definitions, CPU control signals, support chips, interfacing peripherals, addressing modes and much more.

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A guide to the most popular of the 16-bit microprocessors, including the Intel 8086, the Zilog Z8001 and 8002 chips, the DEC LSI-11, Texas Instruments 9900, the Motorola 68000 and the National Semiconductor 16000 family.

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Projects and reviews covering hardware, memory expansion, popular home computers and software examples for beginners and experienced programmers.

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A beginner's guide to interfacing principles. Includes discussions of practical applications for microprocessors, the 6809 signal set, hardware and software architecture and modular programming. Many examples and programs. Limited supplies.

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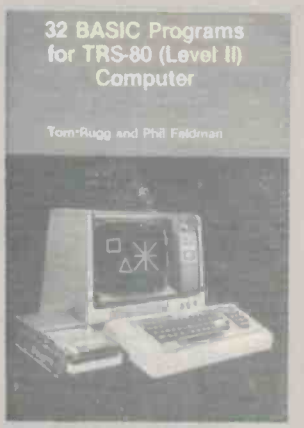

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MINI-MART

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COMMUNICATIONS

WANTED: MANUAL, Circuit Diagram, or any information for a MARC Model NR 52FI multiband receiver. J. Hyde, 4 Birchdale Pl, Christchurch 3, New Zealand.

FOR SALE: RECEIVER Heathkit SB303 amateur bands 3.5 MHz to 30 MHz and 15 MHz to 15.3 MHz (WWV) with test cards, manual, AM and SSB filters, speaker HS24, $450 ono. J. Cleret, Linton, Bombala, NSW 2632. (0648) 87-252.

WANTED: PLANS for HF receiver also for projects using CA3005 RF amplifier. Will pay. M. Krawczuk, 99 Pyap St, Renmark, SA 5341.

FOR SALE: IC22S $150, IC502 $125, Kenwood TS520S $450, Yaesu FT2FB $75, Ken KP202(H/H) $100, Ken Rotator $100. W. Greenrich, 69 Bay Rd, Bolton Point, NSW 2283.

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FOR SALE: J. H. FORMULA IV tone arm, $60. Transcriptor Fluid tone arm, $75. (02)869-1840.

FOR SALE: STEREO Amp. 30 WRMS Not yet completed, with papers, diagrams, preamp, much more. Owes me $180, will sell $110. M. Sully, 33 Odessa Ave, Keilor Downs, Vic. 3038.

FOR SALE: CASSETTE DECK TEAC CX 350. Dolby, metal tape, auto memory rewind. Superb condition. Recommended by leading Hi-Fi magazine. $105 ono. Chris Tinney, 8 Carbethon Cres, Beverley Hills, NSW 2209. (02) 759-5052.

WANTED: CASSETTE duplicator or copier for C90 tapes, working or not. Lachlan (02)636-4686.

COMPUTERS

FOR SALE: ATARI 400 Computer 16K including accessories, basic cartridge worth $100. Perfect condition $389. G. Coddington, P.O. Box 1238, Parramatta, NSW 2150. (02) 631-7631.

FOR SALE: ACT VIC-20 Users Group bi-monthly magazine. Many interesting programs and articles. June issue $2. Bi-monthly $12 Write Chris Groenhout, 25 Kerferd St, Watson, ACT 2602. (062) 41-2316.

FOR SALE: SUPER 80 Disassembler cassette $9. Siemens Teleprinter $50. Teleprinter keyboard, tape reader and punch $75. R. Vowels, 93 Park Drive, Parkville, Vic. 3052.

FOR SALE: VIC-20 Program Library. High quality games, utilities, educational and miscellaneous programs available. For list send SAE to Chris Groenhout, 25 Kerferd St, Watson, ACT 2602. (062) 41-2316.

FOR SALE: WORDBEE ROMs plus documentation $30. 8K OSI computer plus monitor $140. Wanted: ASCII keyboard good price. Ray Fairall 6/102 Wyadra Ave, Harbord, NSW 2096. (02) 938-4767.

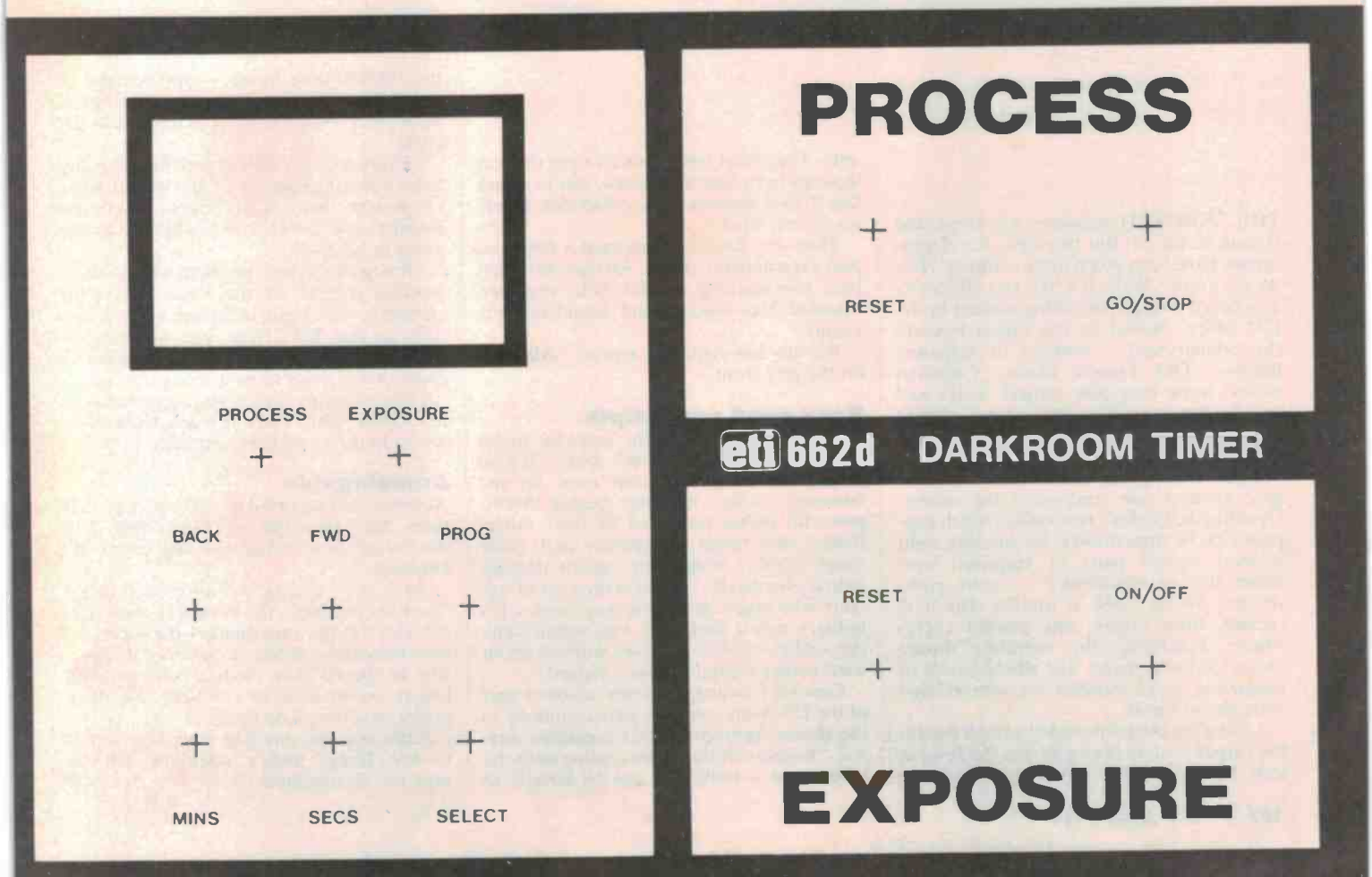
FOR SALE: TRS-80. Mod 1 48K, Two drives with TRSDOS, SCRIPSIT, Ledger and Inventory control for $1500. Tony Grimes, 17 Kay St, Mt Waverley, Vic. 3149. (03) 429-2044.

SWAP: APPLE software (including CPM). Send list and details of software interest to Wolfgang, P.O. Box 640, Maryborough, Qld. 4650.

MISCELLANEOUS

FOR SALE: OSCILLOSCOPE BWD 539D (similar 820) dual trace dc-25 MHz. Probe and manual. Never been used (stroke victim) $575. S. D. Payne, 5 Knight Ave, Yokine, WA 6060. (09) 349-1919.

FOR SALE: TRANSFORMER 240 Vac to 115 Vac. 1 kW. In Pro metal case with handle and socket/plug. Australian made. $100 ono. David Hire, 34 Alfred St, Annandale, NSW 2038. (02) 692-0060.



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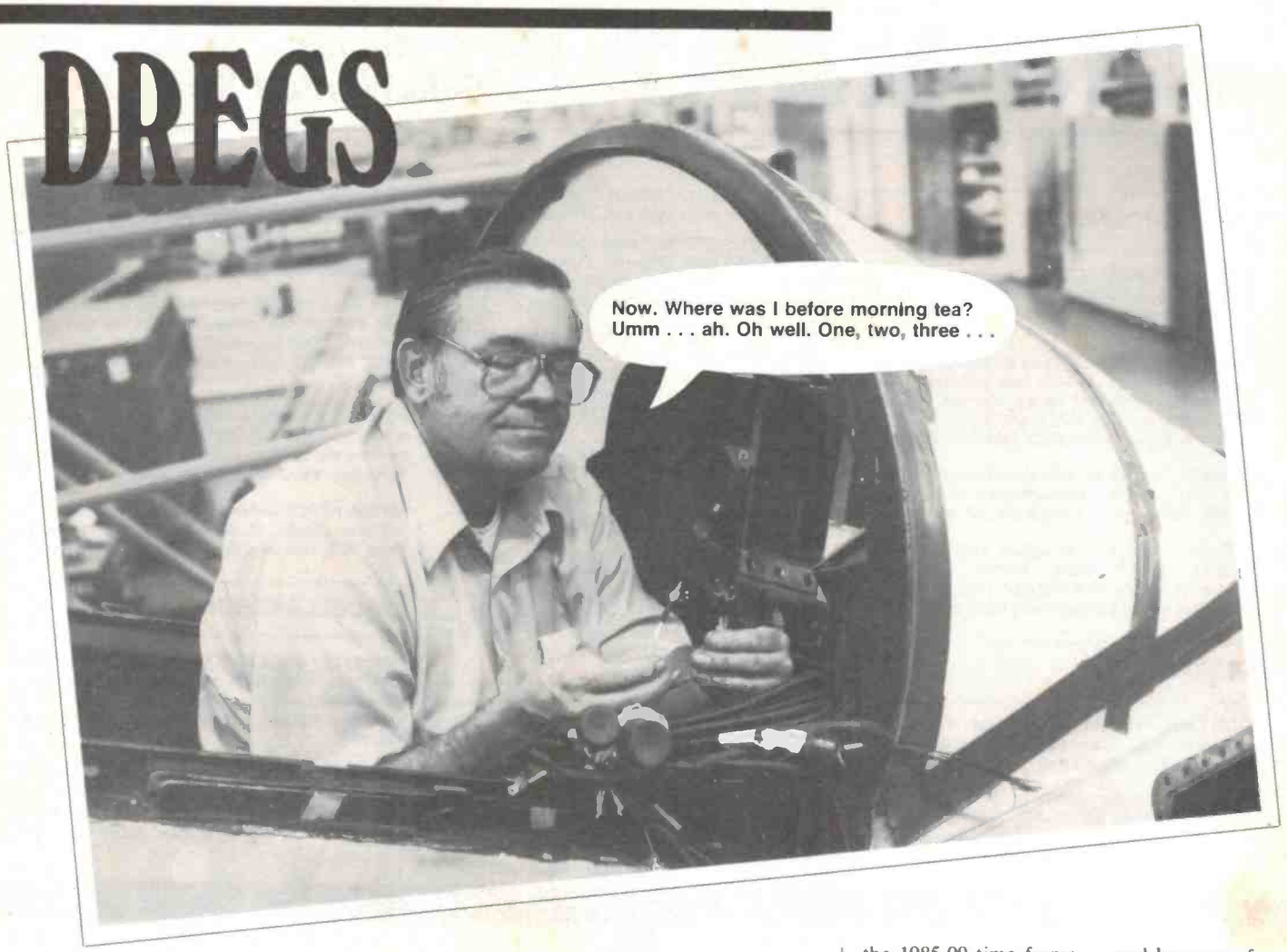

THE SKIRMISH between Argentina and Britain is still on! But this time, the Argentinians have been much more cunning. How do we know? Well, it's like this. Recently we shifted a large plan-filing cabinet in the ETI office. Stored on the carpet beneath the cabinet were a number of magazine binders. Old French issues, Canadian issues, some long past project books and one binder containing 1982 issues of ETI UK. (We've run out of shelf space — hint, hint).

Upon moving this latter binder, a veritable sawdust pile confronted the mover. Opening the binder's rear cover (which happened to be uppermost), an amazing sight greeted several pairs of surprised eyes amidst loud exclamations (". . . golly, gosh, oh gee, oh my, look at that!"). The next second, little brown ants poured everywhere. Fearlessly, the crowding throng inspected the carnage. The whole binder of magazines, a 12 month's set, was riddled with an ant's nest!

Lifting the binder revealed a small hole in the carpet leading through from the cement slab floor beneath. Amazing! Argentine ants. They must have chewed right the way through from South America, just to attack this British Bastion in the antipodes. Devilish clever, what?!

That very day we summoned a flotilla of pest exterminator chaps. Arriving two days later (no mucking around, lads) they surrounded the outpost and liquidated the enemy.

We are now happy to report: "All quiet on the etty front".

Rosy-eyed conscripts

"Don't look up," said the sergeant to his platoon. "Better still, don't look." It's no longer 'smoke gets in your eyes' for the common soldier, it's laser beams. Short, powerful pulses produced by laser rangefinders and target designators that guide smart bombs, while they cannot damage military hardware, can harm the eyes of soldiers who might get in the way, says a US military report (although, one would think the soldiers should be more worried about what comes *behind* the laser pulses!).

General Edward C. Meyer, chief of staff of the US Army, recently gave testimony to the House Appropriations Committee, saying: "Because of the lasers coming onto the battle-field — both ours and the Soviets' in the 1985-90 time frame — and because of the ballistic injuries experienced in Israel, we project a large number of injuries to the eyes.

"Every soldier on that battlefield is going to be wearing goggles . . . and we will have to protect them from lasers all around because you never know where you are going to be lased.

"It is going to be a problem with soldiers wearing goggles all the time. It is hard enough to look a guy in the eye and tell him 'Get up that hill'. Now, you will have to look through two rose-coloured glasses. I guess that is going to be a change in wars."

(The colouring, by the way, is intended to filter laser light before it reaches the eyes, not to improve soldiers' attitudes.)

Amazingable

New Scientist reported in a recent issue that their San Francisco correspondent had discovered new words popping up in the language.

At a beer tasting, for what was called "London real ale", the brew was *characterful*. Over at the supermarket the food was *microwaveable*. While at Stanford University he heard that medical scientists no longer expose cells to UV light. No, they prefer to ultraviolate them.

From now on, any daft story that comes to the Dregs team's attention will be regarded as *dregsable*. ●

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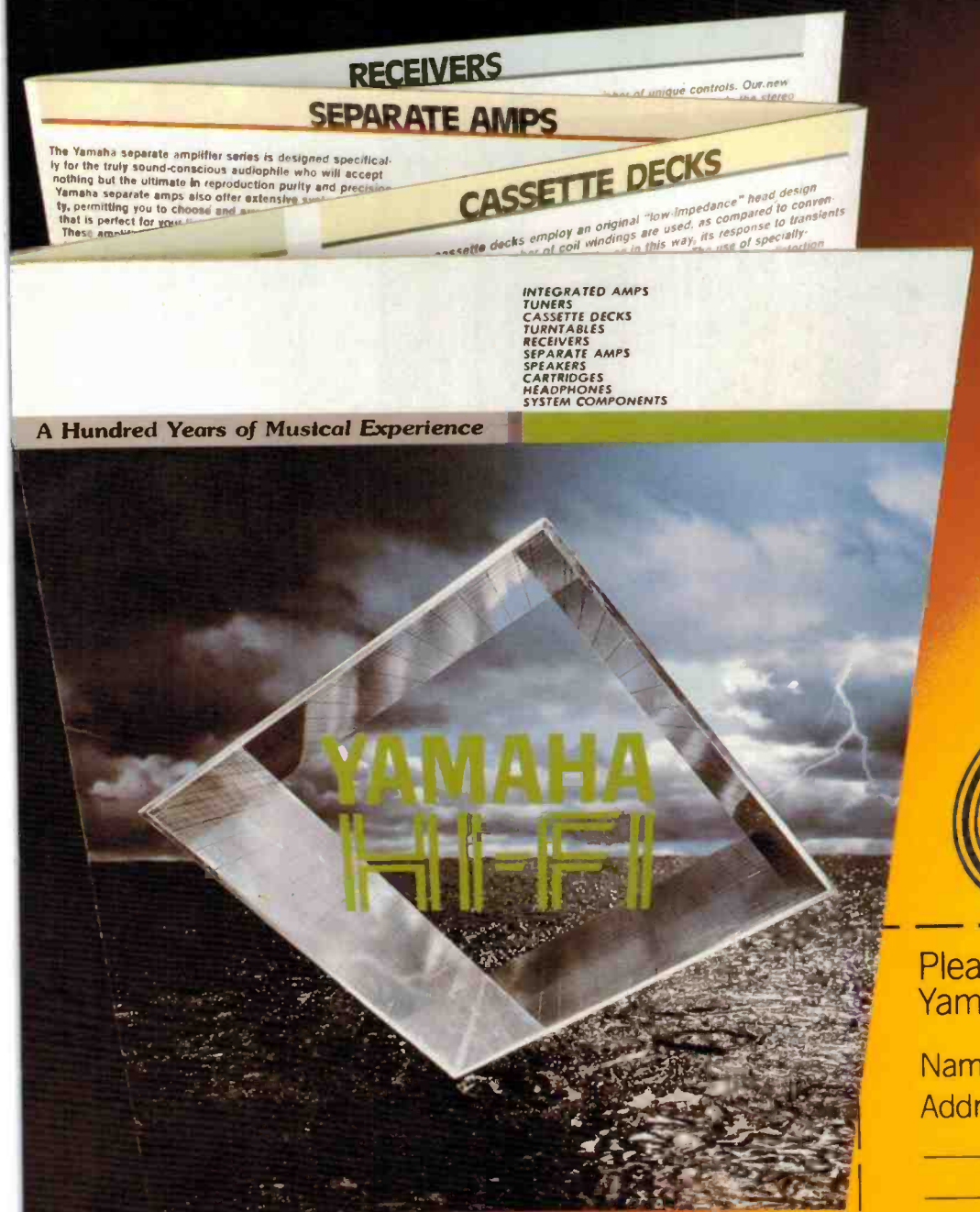

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